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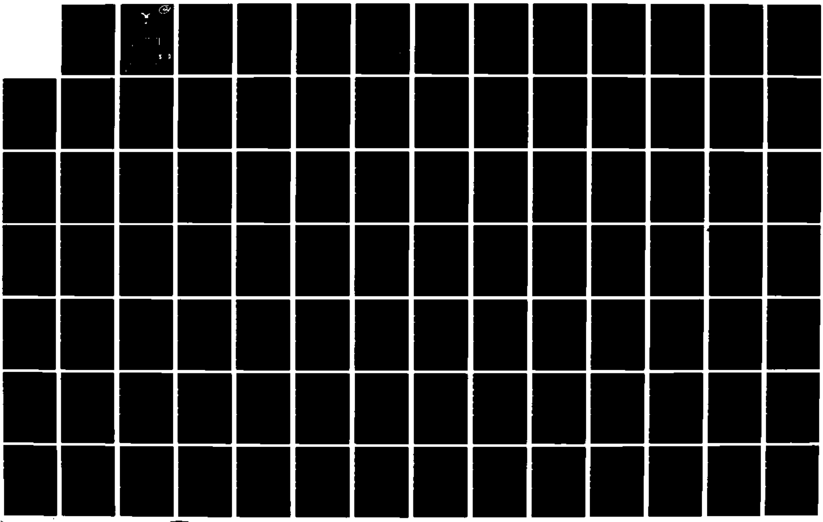

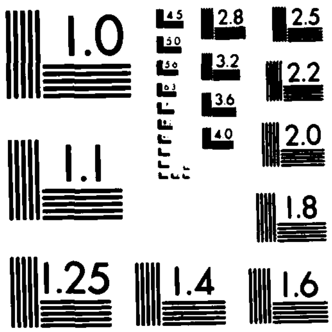

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JOB ENRICHMENT APPLICATION TO CIVILIAN ENGINEERS IN BASE CIVIL ENGINEERING ORGANIZATIONS

Charles P. Smiley, 1Lt, USAF

LSSR 71-82

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This research examined the feasibility of applying job enrichment techniques to civilian engineers within Base Civil Engineering (BCE) organizations. Job enrichment techniques are managerial efforts to improve work environments and to motivate employees. Not all employees, though, need or desire job enrichment. Hackman and Oldham developed the Job Characteristics Model to determine the potential reception to these techniques by any employee group. Their model also measures five core job dimensions as reported by job incumbents. This research surveyed 358 BCE civilian engineers to solicit their job perceptions. Using the Job Characteristics Model as a guide, these measured perceptions were compared against those of similar groups previously evaluated. Also tested were any inter-group differences between several BCE civilian engineer positions (i.e., Deputy Base Civil Engineers, Design Engineers, etc.) and between categories (i.e., age, grade, etc.). Data analysis detected the existence of several significant differences and trends. Applying job enrichment techniques was not found to be a feasible approach for all BCE civilian engineers. However, several groups within this population would seem to benefit from their application.

LSSR 71-82

JOB ENRICHMENT APPLICATION TO CIVILIAN ENGINEERS IN BASE CIVIL ENGINEERING ORGANIZATIONS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Engineering Management

By

Charles P. Smiley, BSCE
First Lieutenant, USAF

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This thesis, written by

First Lieutenant Charles P. Smiley

has been accepted by the undersigned on behalf of the faculty of the School of Systems and logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN ENGINEERING MANAGEMENT

DATE: 29 September 1982

David R Lee

COMMITTEE CHAIRMAN

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This thesis is dedicated with love to my wife Denise and our daughter Andrea.

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CHAPTER 1

INTRODUCTION

Background Information

In 1947, when the United States Air Force became a separate branch of the Armed Forces, it gained control of $1 billion of land and facilities relinquished by the Army. The Air Force, however, lacked an internal overseer to maintain or add to these acquired assets. Out of this need developed the Base Civil Engineering (BCE) organization, manned by engineers and craftsmen. The BCE function was charged to maintain and repair all existing base real property, and to construct or acquire new assets, in support of the Air Force mission and its people (38:1-1). Currently, all contiguous United States Air Force bases contain a BCE organization composed of both a military and civilian component to satisfy these responsibilities.

Recent studies indicate a growing deficit in the number of military and civilian engineers in the BCE organization. In May 1981, less than 86 percent of the 2000 officer BCE engineering positions were filled (3:8). Civilian engineer fill rates in BCE were scarcely better at 88 percent of the 1600 authorizations (23). Projections for the future within BCE organizations are not promising

as Air Force Civil Engineering has encountered increasing difficulties in retaining engineers, civilian and military.

Air Force Civil Engineering cannot permanently absorb these losses while retaining the ability to perform its mission. According to Mr. Charles T. Johnson, Chief of the Engineering and Services Career Program Branch, the shortage of BCE civilian engineers is one of the "top three" problems facing Air Force Civil Engineering management, falling behind combat readiness of BCE troops and management of energy resources in its importance (23). Mr. Harry P. Rietman, Associate Director of Engineering and Services, concurs with the severity of the BCE civilian engineer deficiency (34). This deficit is the result of two factors.

The first factor is the reduced recruiting ability of Air Force Civil Engineering. This is largely due to the sizable pay difference between comparable private sector and BCE civilian engineering jobs. A new bachelor of science in most engineering fields can choose from several job offers in the private sector beginning at over $20,000 annually (25:84). The same graduate would initially earn less than $16,000 annually as a BCE civilian engineer. The second factor is the problem of retaining the existing BCE civilian engineers (23; 34). The retention problem, the force behind this research effort, has two potentially significant causes.

Recent civilian manpower ceilings have hampered recruiting efforts, increasing the emphasis upon retaining the current engineer work force. Since 1967, the Air Force has experienced a 34 percent decrease in its entire civilian employee authorizations. In 1981, the Air Force's need for civilian engineers of all types increased 12.5 percent (39: 35). The BCE organization has been one of the victims of this predicament. The demands placed upon its engineers have subsequently increased significantly, resulting in a "do more with less" situation (34). In such a situation, BCE civilian engineers may look increasingly toward private sector employment.

The changing role of the BCE engineer also affects the retention of civilian engineers. In the past, an engineer in a BCE organization was expected to be deeply involved in the technical aspects of design and construction of facilities. Today, though, the engineer is required to manage architectural-engineering contracts and be somewhat removed from the technical portion of the work. For an engineer seeking to perform technical design work, this shift in emphasis from technical to managerial may become a deterrent to the engineer's retention with the Air Force (34).

One Possible Solution

In examining the possible causes of the Air Force's civilian engineer retention problem, the reader may have

noticed that both reasons dealt with extrinsic factors of the job. These forces are largely beyond the control of most managers of Base Civil Engineering organizations. Another cause not yet discussed is that of the internal factors of the engineer's work itself. If negative attitudes exist between the worker and the job, voluntary employee turnover is a likely result (19:280). High turnover rates, of course, are synonymous with a retention problem.

Job redesign is one technique which shows considerable promise in attacking employee turnover. Job redesign is "the deliberate purposeful planning of a job, including any or all of its structural or social aspects [36:2]." This study will examine one specific approach to job redesign--job enrichment--as a possible solution to BCE civilian engineer job dissatisfaction and subsequent turnover.

Job enrichment changes the nature of the job, enabling incumbents to fulfill a larger portion of their needs through intrinsic (as opposed to external) factors (such as pay, supervision, etc.). Horstman and Kotzun report that several behavioral scientists feel that "job enrichment would inevitably lead to more satisfied, motivated, and productive workers [20:2]." A special task force to the Secretary of Health, Education and Welfare reported in 1973 that job enrichment was the best selection

of several methods to "improve the quality of life for millions of Americans at all occupational levels [40:xviii]."

Applicability of Study

Two possible benefits may result from this study. First, the research will provide recommendations for improving the BCE engineering work place and enhancing its desirability for employment. In such an environment, Air Force BCE may experience increased retention of all its engineers, civilian and military. Second, the findings may be applicable toward other Air Force professionals (for instance, scientists or R&D engineers). It is possible that the job attitudes of BCE civilian engineers are similar to that of these other professionals. This research on BCE civilian engineers could then provide information relevant to implementing job enrichment techniques in other job settings.

Scope

The term "engineer," as used throughout this study, refers to one who has received at least a Bachelor of Science degree in any of the technical engineering disciplines such as Architecture, Civil Engineering, Electrical Engineering, or Mechanical Engineering. An engineer, either in BCE (as an "800 Series" General Schedule employee) or employed in private industry, merely has to possess one of the requisite undergraduate degrees to carry the title. The individual

does not have to be assigned to any technical duties by an employer to be considered an engineer.

Problem Statement

Air Force Base Civil Engineering is experiencing problems in retaining its civilian engineers. Several potential causes of this problem (such as pay and promotion) are beyond the control of most BCE managers. One possible solution, though, is controllable by these managers: the introduction of job enrichment techniques to the work place. Before these techniques are introduced, however, a preliminary evaluation of the job incumbents should take place.

Research Objectives

This study has several objectives dealing with the application of job enrichment techniques to Base Civil Engineering organizations. The first three objectives examine the feasibility and expected reception of introducing job enrichment measures to civilian engineers, as a <u>collective group</u>, within BCE organizations.

<u>Research Objective One</u> - Determine the feasibility of applying job enrichment techniques to BCE civilian engineers.

<u>Research Objective Two</u> - If job enrichment is determined to be a feasible approach, determine the specific core job dimensions which need to be dealt with to motivate these engineers.

Research Objective Three - Evaluate the potential reception of job enrichment efforts by civilian engineers in BCE organizations.

The last four objectives examine the feasibility and expected reception of introducing job enrichment measures to specified groups of BCE civilian engineers.

Research Objective Four - Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in all BCE civilian positions.

Research Objective Five - Determine if the core job dimension measures are approximately equal for all BCE civilian engineering positions.

Research Objective Six - Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in both categories (i.e., age and grade) of BCE civilian engineers.

Research Objective Seven - Determine if the core job dimension measures are approximately equal for both categories (i.e., age and grade) of BCE civilian engineers.

CHAPTER 2

LITERATURE REVIEW

An organization such as the Base Civil Engineering function is "a social system deliberately constructed to coordinate the activities of people seeking common goals [2:486]." From a management perspective, an organization's primary goals must be that of insuring productivity and efficiency of the work force. To accomplish these goals, a variety of management philosophies have evolved in the American work place throughout the 20th century.

Early Management Theories

Two early philosophies included Social Darwinism and the New Thought Movement. Social Darwinism held that the function of organizations was merely to provide a setting in which only the most deserving employees prospered. The New Thought Movement taught that an employees' success in an organization is a function of how badly one wanted to succeed. (2:488-491) In 1911, Frederick W. Taylor and Morris L. Cooke set down the principles of a new management philosophy in Taylor's The Principles of Scientific Management (41:736). Scientific management, "the first truly significant breakthrough in management ideology and practice," placed primary emphasis on the solution of organizational problems by

scientific methods (2:492-493). This philosophy assumed that by applying human factors studies (such as time and motion studies) to the work place, organizations could become more efficient and productive and employees could enjoy easier, higher-paying jobs. The Scientific Management philosophy, however, viewed people through a very narrow perspective. Workers were merely considered as another capital investment of the organization--as an adjunct to the operation of the machinery--and were viewed primarily in economic terms. (2:493-494) This theory, although not totally discarded by managers today, did not pass the test of time. Both workers and their attitudes have changed significantly since the introduction of these management philosophies. All three of the above theories concentrated on maintaining a high degree of employee productivity and efficiency. They ignored the notion that if a worker is productive and efficient but dissatisfied with the work, a number of adverse effects may result, including turnover. (7:12; 15:42) Several modern theories have been developed to improve the job, both in the eyes of the worker and of management. One such theory is that of job redesign.

Job Redesign

Job redesign deals with jobs having too narrow scope and too narrow depth (2:307). Job scope refers "to the number of different operations performed by the worker and

to the frequency of repetition of the job cycle [2:306]." Job depth refers "to the relative influence workers have over their work environment and the degree to which they can plan and carry out their work under conditions of self-control [2:306]." Three approaches of redesign are available to managers: job rotation, job enlargement, and job enrichment. Job rotation merely rotates an employee through several jobs and is used both to counteract worker monotony and train the worker. Job rotation deals with limited job scope. Job enlargement, or horizontal job loading, also focuses on limited job scope by granting more responsibility for more tasks to an employee. Job enrichment, however, focuses on job depth. (2:307-308) Also called vertical job loading, job enrichment makes human reactions to the job its primary consideration by attempting to match <u>actual</u> job outcomes with an employee's <u>expected</u> job outcomes (2:309; 7:4). This match is essential in order to maintain employee satisfaction and to obtain high worker productivity and efficiency, the "ultimate objective of job redesign [2:309]." Although job rotation and enlargement are both viable strategies, this study will only examine the job enrichment approach to work redesign in a Base Civil Engineering organization.

<u>Herzberg's Two-Factor Theory</u>

The theory of job enrichment began with the pioneering work of Frederick Herzberg and his associates. Their

work was aimed at increasing employee's motivation and satisfaction, thereby reducing turnover. (16:57) Herzberg's two-factor theory has been "by far the most influential theory to work (job) redesign [14:251]." The two factors are "hygiene" and "motivator." Hygiene factors are those which prevent employee dissatisfaction, and include company policy and administration, supervision, working conditions, and salary. It should be noted that all these factors are extrinsic to the job itself and are found in the job environment. (16:57) Motivator factors, on the other hand, deal with intrinsic, or job content, stimuli. These factors include achievement, recognition for achievement, responsibility, and growth. (16:57) Whereas hygiene factors simply avoid job dissatisfaction, motivator factors can cause job satisfaction by motivating employees to superior effort and performance (14:251). In job redesign terms, changes dealing only with the hygiene factors should not cause an increase in employee motivation. Only to the degree that motivator factors are designed into the work itself will employee motivation and satisfaction result. (14:251) To substantiate these claims, Herzberg performed 12 investigations of factors affecting job attitudes. He found that 81 percent of the job satisfaction causes were motivators, and that 69 percent of the causes of job dissatisfaction were hygiene factors. (18:57)

Researchers, however, have discovered limitations in the usefulness of Herzberg's model to describe causes of job satisfaction and motivation (14:251). Foremost among these problems is the inability to provide empirical support for the major tenets of the theory (14:251). Several studies have found the theory to be "an oversimplification of the sources of job satisfaction and dissatisfaction [21:387]." Secondly, Herzberg's theory does not specify how to measure the presence or absence of motivator factors in existing jobs. This sorely limits the degree to which the theory can diagnose jobs planned for redesign or evaluate a redesigned job's effectiveness. (14:252) Finally, Herzberg's model does not take into consideration individual differences among people in their response to job enrichment efforts employing two-factor methods (14:251). House and Wigdor, in a review of 31 studies of Herzberg's theory, concluded that "a given factor can cause job satisfaction for one person and job dissatisfaction for another person [21:386]."

The view that individual differences moderate an employee's response to job enrichment efforts is based on the work of Turner and Lawrence in 1965 (14:254). In essence, their work concluded that in a job redesign effort, managers need to realize that workers, having their own needs and predispositions, will respond to such an effort with behavior peculiar to that situation (37:119).

Subsequent research lends support to this proposition of the importance of individual differences (14:255). Moreover, job redesign, and in particular job enrichment, of all jobs and for all workers has not proved to be the best approach (7:14; 11:130). In response to these findings, Hackman and Oldham developed the Job Characteristics Model. This model considers these individual differences and evaluates the potential reception of job enrichment efforts by an organization's employees.

Job Characteristics Model

The basic theory behind the Job Characteristics Model is outlined in Figure 2-1. Basically, it proposes that

> Positive personal and work outcomes (high internal motivation, high work satisfaction, high quality performance, and low absenteeism and turnover) are obtained when three "critical psychological states" are present for a given employee (experienced meaningfulness of the work, experienced responsibility for the outcomes of the work, and knowledge of the results of the work activities [13:160].

When the three critical psychological states are present, employees develop high degrees of self-esteem when their performance is good. These positive feelings will prompt the employees to continue to perform well. This results in internal motivation. (16:58) All three of these states must be present for the positive outcomes to be realized, since absence of one decreases motivation significantly (13:160; 16:58). These states are created by the presence of five "core" job dimensions:

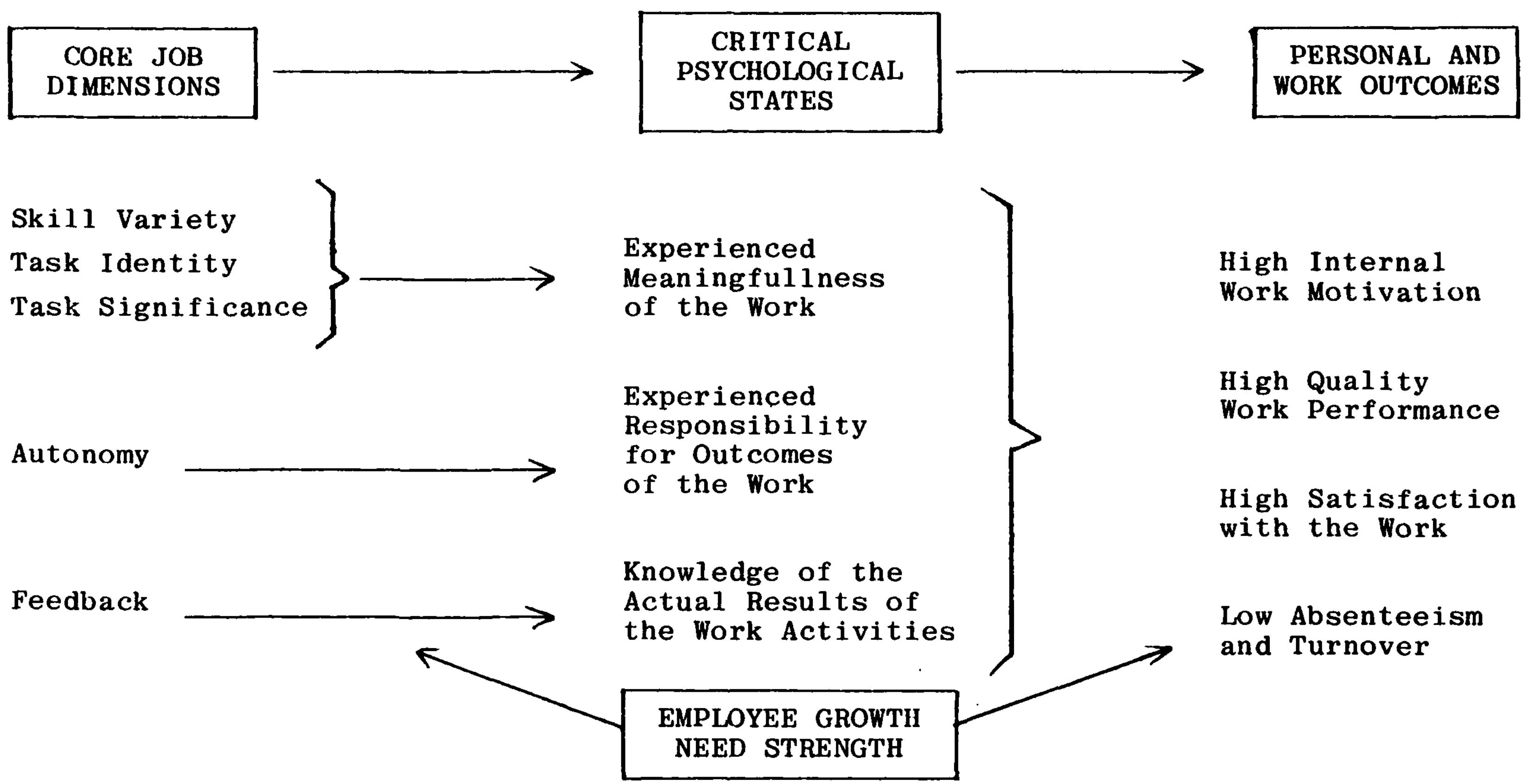

Figure 2-1. The Job Characteristics Model (14:256)

1. Skill Variety. The degree to which a job requires a variety of different activities in carrying out the work, which involve the use of a number of different skills and talents of the employee [13:161].

2. Task Identity. The degree to which the job requires completion of a "whole" and identifiable piece of work--that is, doing a job from beginning to end with a visible outcome [13:161].

3. Task Significance. The degree to which the job has a substantial impact on the lives or work of other people--whether in the immediate organization or in the external environment [13:161].

4. Autonomy. The degree to which the job provides substantial freedom, independence, and discretion to the employee in scheduling the work and in determining the procedures to be used in carrying it out [13:162].

5. Feedback from the job itself. The degree to which carrying out the work activities required by the job results in the employee obtaining direct and clear information about the effectiveness of his or her performance [13:162].

As can be seen from the model, three core job dimensions ("Skill Variety," "Task Identity," and "Task Significance") contribute to the experienced meaningfulness of the work; "Autonomy" contributes to experienced responsibility; and "Job Feedback" contributes to knowledge of results.

Based on the theory outlined in Figure 2-1, a researcher can generate a single summary index which reflects the overall internal motivating potential of a job (13:161). This index, the "Motivating Potential Score," is determined by the following formula:

$$\text{MOTIVATING POTENTIAL SCORE (MPS)} = \frac{\text{SKILL VARIETY} + \text{TASK IDENTITY} + \text{TASK SIGNIFICANCE}}{3} \times \text{AUTONOMY} \times \text{FEEDBACK}$$

The measurements for the five core job dimensions are obtained from an instrument called the Job Diagnostic Survey (JDS) developed by Hackman and Oldham. From job-holders' responses to the survey, measures of the job dimensions are tabulated. By looking at the above formula for MPS, an increase in any of the five core job dimensions increases the job's MPS. Because of the multiplicative relationship, however, if any of the three major components are low, the job's MPS will also be low.

A job high in MPS will not affect all employees in the same manner (13:160). The JDS also provides for the measurement of "the respondent's desire to obtain 'growth' satisfaction from his/her work [13:162]." This measure, called an individual's "Growth Need Strength," is the individual difference component found lacking in previous job enrichment evaluation models. The Growth Need Strength (GNS) of an employee influences how positively an employee will respond to a relatively high MPS job (13:163; 32:93).

Implementing Job Enrichment

A multitude of approaches exist by which managers may enrich a job. Five of these approaches outlined by Hackman and Oldham are presented here: combining tasks,

forming natural work units, establishing client relationships, vertically loading the job, and opening feedback channels. This research will not recommend one approach over another, but presents them simply for the reader's consideration.

Combining tasks. By combining existing, fractionalized tasks into new and larger units of work, a job's Skill Variety and Task Identity can be increased. Instead of having a series of workers perform separate, small parts of the job, one person completes a given piece of work. (15:135-136)

Forming natural work units. Task Significance and Task Identity may be increased by grouping the items of work into logical or inherently meaningful categories. This contrasts with assigning work in a purely random manner. Formation of these units, for example, may provide continuing responsibility for a certain customer by an employee and foster a growing sense of how one's work affects that customer. (15:136-137)

Establishing client relationships. The core dimensions of Job Feedback, Skill Variety and Autonomy may be increased by enabling employees to establish direct relationships with the clients of their work. The client must be clearly identified, a direct contact between worker and client must be established, and criteria by which the client may judge the worker's output must be set up. (15:138)

Vertically loading the job. A worker's Autonomy may be increased by vertically loading the job. This narrows the gap between the doing and the controlling parts of the work. The idea is to progress an employee from a position of highly restricted authority to near-total authority for the work. (15:138-139)

Opening feedback channels. Job Feedback may be increased by the removal of barriers which isolate employees from relevant work-related information. The intent is to provide direct, immediate, and regular feedback to workers about their job performance. (15:141)

Strategy for Job Enrichment

Hackman and Oldham suggest a four-step strategy for diagnosing a job for possible future job enrichment techniques. The first step is to examine the motivation and satisfaction scores of the focal job as reported by several sources. This will determine if the real problem with employee work outcomes is, in fact, intrinsic to the job. These scores may be determined through a variety of other methods conducted by multiple observers. (15:102; 16:61) For instance, observers may administer the Job Characteristics Index (developed by Sims, Szilagyi and Keller) to measure respondents' job satisfaction. Possible observers include the job incumbents themselves, their supervisors, or outside consultants. If motivation and satisfaction are

determined to be problematic, the next step is to administer the JDS and examine the job's MPS.

In and of itself, the job's MPS is meaningless. By comparing the job's MPS with that of other jobs, however, one can determine the possible causes of the motivation problems. If the first step shows that the MPS is relatively low, the job itself may be the cause. If the MPS is relatively high, other factors such as pay or supervision may be causing the motivational difficulties. (16:61) Step three involves examining each of the critical job dimensions to determine specific strengths and weaknesses of the job as it is currently designed (16:61). The final step investigates the growth needs of the job incumbents to determine their expected reception to job enrichment techniques. Knowledge of high or low GNS scores may prove helpful to management in planning how to introduce job redesign methods. (16:62)

Summary of Findings and Implementation

Support of job enrichment as an approach to improving job satisfaction, and particularly for the Job Characteristics Model of Hackman and Oldham, is manifold throughout the literature (see Appendix A). In the long run, job enrichment techniques have many possible positive effects to offer an organization, including decreased employee turnover (20:137). The implication for Air Force Civil Engineering top management, it would appear, is to investigate the perceptions of its civilian engineers to determine if a need

exists to introduce job enrichment methods to increase retention. If such a need is determined, management can help to decrease employee turnover by working on the core job dimensions of its engineering positions (4).

CHAPTER 3

METHODOLOGY

Introduction

This chapter presents the research design and methodology which were used in this study. Contained within are a description of the population and the sample, the survey and survey approval process, the sampling plan, the data collection plan and variable measurement. Following these are the research hypotheses of this study which were used to evaluate the research objectives outlined in Chapter 1. Finally, some preliminary assumptions for the data analysis are offered, as well as the actual data analysis methodology.

Description of Population

The population which this research examined consisted of the 1,614 BCE civilian engineers in the contiguous United States (CONUS). These engineers comprise the "800 Series" General Schedule (GS) civilian employees in Air Force Base Civil Engineering. They are dispersed among 105 CONUS bases and stations within all Major Air Commands.

Description of Sample

The sample from which analysis was conducted consisted of 482 BCE civilian engineers from the above

population. The sample covered only civilian engineers at the 71 CONUS Air Force Bases. Civilian engineers at Air Force Stations or at the San Antonio Real Property Maintenance Agency (SARPMA) were not sampled. The number of respondents represented a 95 percent confidence interval within which to support findings. The calculations which produced this figure were:

$$n = \frac{[z^2{}_{\alpha/2}]\ [\sigma^2]}{[B^2]}$$

where n = required sample size
z = normal curve area
σ = allowable variance from the population mean
B = probability bound

A 95 percent confidence interval yields a normal curve area, z, of 1.96. The allowable variance, σ, was established by the researcher at ±0.5 units from the population mean. Because the confidence interval was set at 95 percent, the probability bound, B, was *de facto* 0.05. These figures combine to produce the required sample size. (27:241)

$$n = \frac{[1.96]^2\ [0.5]^2}{[0.05]^2} = 384.16, \text{ round to } 385$$

Prior research conducted on Air Force civilian employees with a similar grade structure as BCE civilian engineers (i.e., Air Force Auditors) produced a 75 percent

rate of return of surveys (17:63). To allow for a similar return rate, the above figure was increased by a factor of 1.25:

$$[1.25]\ [385] = 481.25, \text{ round to } 482$$

Therefore, a total of 482 survey instruments were mailed to BCE civilian engineers in the CONUS.

As will be explained in Chapter 4, an insufficient number of replies were returned to achieve a 95 percent degree of confidence. Therefore, all statistical testing was performed at a 90 percent confidence interval employing all acceptable returned surveys.

The Survey

The survey instrument was a two-part package. The first part consisted of a questionnaire which sought personal background data about the respondent. The second part contained the short form of the Job Diagnostic Survey (JDS) developed by Hackman and Oldham. The JDS uses a seven-point Likert scale to measure the respondent's perceptions. The Likert scale can denote if respondents are more or less favorable toward a topic, but how much more or less favorable cannot be ascertained (9:274). The entire survey package, including its cover letter, is located at Appendix B.

Survey Approval Process

The Air Force Manpower and Personnel Center (AFMPC), Randolph AFB, Texas, must approve prospective survey instruments prior to their distribution among Air Force employees, either civilian or military. To secure the approval to survey civilian employees, an additional preliminary step was required. This step was the notification of the several relevant national labor unions.

All federal civilian employees have the right to join a labor organization (6). To avoid possible conflict with any collective bargaining agreements concerning these employees, the presidents of the three relevant labor unions were notified of the forthcoming survey of BCE civilian engineers. The three unions contacted were the National Association of Government Employees (NAGE), the National Federation of Federal Employees (NFFE), and the American Federation of Government Employees (AFGE). The notification letters are located at Appendix C.

Prior to its survey approval, AFMPC allows the contacted union 30 days to respond. In this case, both the NFFE and AFGE replied within 30 days; the NAGE did not respond at all. Neither reply raised objection to the surveying of BCE civilian engineers.

The entire survey package of this research was approved by telephone on 21 April 1982 by Mr. Charles Hamilton of AFMPC and was assigned USAF Survey Control

Number 82-29. Written notification of approval was not received until 4 June 1982.

The Sampling Plan

The method of distributing the survey to the sample was a passive one. That is, specific respondents were not identified by the researcher. Instead, Base Civil Engineers at target bases were mailed a package of several survey instruments. The only directions given for survey distribution were that a quota of BCE civilian engineer jobs was requested to respond at each base. In all instances, several engineers were asked to be sampled from one of the Construction Management, Environmental Planning, or Design Sections, as well as the Deputy Base Civil Engineer. Participation by potential respondents was entirely voluntary. Respondents were provided with a pre-addressed, metered return envelop to obtain an optimal reply rate.

Data Collection Plan and Variable Measurement

Returned surveys provided the raw data input for this research. If a returned survey was not completely filled out, it was not used in data analysis. Replies from the returned surveys were manually typed into a Harris computer file to be used as the data bank for future analysis.

The five Job Characteristics Model (JCM) constructs (Skill Variety, Task Identity, Task Significance, Autonomy,

and Job Feedback), the Motivating Potential Score, and the Growth Needs Strength measure were calculated using the accumulated data from the JDS. Hackman and Oldham developed algebraic formulas to measure each of these seven variables. A brief description of the variables and the method of their measurement is presented in Appendix D.

Research Hypotheses

A series of research hypotheses were formulated to evaluate the research objectives of Chapter 1. The sequence of objectives and their related hypotheses follow the job enrichment evaluation strategy suggested by Hackman and Oldham (see Chapter 2). The three initial research objectives dealt with evaluation of BCE civilian engineers as a collective group compared to other similarly-structured groups. The final four research objectives examined within-group differences among BCE civilian engineers, first by position and then by category (i.e., age and grade).

The first research hypothesis was used to evaluate *Research Objective One:* Determine the feasibility of applying job enrichment techniques to BCE civilian engineers.

RESEARCH HYPOTHESIS ONE. The Motivating Potential Score of BCE civilian engineers is greater than that of other similarly structured groups (as measured by previous research employing the Job Diagnostic Survey).

The next research hypothesis was used to answer *Research Objective Two:* If job enrichment is found to be a

feasible approach, determine the specific core job dimensions which need improvement to motivate these engineers.

RESEARCH HYPOTHESIS TWO. The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of BCE civilian engineers are higher than the corresponding measure of other groups.

The third research hypothesis was developed to evaluate *Research Objective Three:* Evaluate the potential reception of job enrichment techniques by civilian engineers in BCE organizations.

RESEARCH HYPOTHESIS THREE. The Growth Need Strength measure of BCE civilian engineers is greater than that of other groups.

The scope of evaluation here shifts from examining BCE civilian engineers as a collective group to analyzing these engineers amongst themselves in predetermined categories.

The next research hypothesis was used to evaluate *Research Objective Four:* Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in all BCE civilian engineering positions.

RESEARCH HYPOTHESIS FOUR. The MPS/GNS measures of all BCE engineering positions are approximately the same.

The next research hypothesis was used to answer *Research Objective Five:* Determine if the core job dimension

measures are approximately equal for all BCE civilian engineering positions.

RESEARCH HYPOTHESIS FIVE. The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineering positions are approximately equal.

The next two research hypotheses were used to evaluate *Research Objective Six:* Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in both categories (i.e., age and grade) of BCE civilian engineers.

RESEARCH HYPOTHESIS SIX. The MPS/GNS measures of all BCE civilian engineers are approximately equal regardless of age.

RESEARCH HYPOTHESIS SEVEN. The MPS/GNS measures of all BCE civilian engineers are approximately equal regardless of General Schedule grade level.

The final two research hypotheses were used to answer *Research Objective Seven:* Determine if the core job dimension measures are approximately equal for both categories (i.e., age and grade) of BCE civilian engineers.

RESEARCH HYPOTHESIS EIGHT. The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineers are approximately equal regardless of age.

RESEARCH HYPOTHESIS NINE. The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineers are approximately equal regardless of grade.

Data Analysis Assumptions

Before discussing the method of data analysis, it is important to point out several assumptions made in this research. The first concerned the data derived from the Likert seven-point scales in all five sections of the JDS. The Likert scales produce ordinal level data (9:274). These scales seek responses ranging from "extremely negative" to "moderate" to "extremely positive." For the purposes of this research, the interval between each of the seven response points was assumed to be equal. The importance of this assumption was that its acceptance allowed the use of parametric instead of nonparametric statistical testing procedures. When interval level data or better is analyzed, parametric testing may be conducted. Parametric tests are so versatile, accepted, and understood that they are often used with ordinal data which seems to approach interval scales in nature (9:124).

The final two assumptions made in this research were that initially the accumulated data was normally distributed with an approximately equal variance. The former may reliably be claimed because of the Central Limit Theorem,

which states that

> . . . for large sample sizes, the mean $\bar{x}$ of a sample from a population with mean μ and has a standard deviation σ has a sampling distribution that is approximately normal, regardless of the probability distribution of the sample population [27:198].

The equal variance assumption follows from a logical continuation of the Central Limit Theorem. Specifically, for large sample sizes the variance of the several treatments is equal to the variance of the overall sample divided by the square root of the sample size (27:198). Most statistics texts do not specify the required size of a "large" sample size. However, this research's sample size of 358 was assumed to satisfy the large sample size criteria (35).

Parametric testing may be conducted only upon data which has an approximately normal probability distribution and which has approximately an equal variance with the overall sample. The necessity of meeting these two criteria is a matter of debate in the literature. The theory subscribed to in this research is attributed to Kirk's test on experimental design. Kirk claims that unless the data's departure from approximate normality is extreme, test results will have fewer errors than results from data with unequal variances. Nonhomonenous variances can markedly affect research for unequal sample sizes. (24:61; 27:491)

Data Analysis

In order to answer the research hypotheses specified earlier in this chapter, a methodology of data analysis was required. This section describes that methodology. The data analysis was divided into three distinct parts to evaluate the research hypotheses. The first part compared the collective BCE civilian engineer group against other reported research using the JDS. The second part, which contrasted the BCE civilian engineering positions' scores against each other, depended upon standardized statistical packages of the AFIT computer system. The final part compared BCE civilian engineer categories (i.e., age and grade) against each other. This part relied upon both programmed and manual statistical procedures. Figure 3-1 presents the model of testing for this research.

Research Objectives One through Three

Motivating Potential Scores regarded in isolation have no meaning, nor do Growth Needs Strength or the five JCM construct measures. Therefore, the methodology for analyzing the first three research objectives, which contrasted BCE civilian engineers' measurements with exterior groups' norms, was accomplished by comparisons with prior research results of the several measures.

The first research objective, comparing MPS norms, was examined by several methods of evaluation. All three

GROUP EXAMINED	COMPARISON	METHOD OF TESTING	VARIABLES MEASURED
BCE Collective Group	Other Similar Groups	Nonstatistical Comparison	MPS, GNS, SV, TI, TS, A, JF
BCE Positions	Themselves	Parametric or Nonparametric	Same
BCE Categories (Age, Grade)	Themselves	Parametric or Nonparametric	Same

Figure 3-1. Model of Testing

methods employed prior research on similar groups of employees as BCE civilian engineers.

The first such method of comparison was with data compiled by VanMaanen and Katz in 1974. These researchers administered the Job Diagnostic Survey to a large sample of public employees. Of the 3,500 people sampled, 3,059 (87.4 percent) responded. This sample was then stratified into eight relatively homogenous job categories. One of these categories, "professionals," included occupations requiring specialized and theoretical knowledge, usually acquired through college training or through work experience. Engineers were included in this group of 477 respondents (15.6 percent of all respondents). (11:82-84) Unfortunately, no further breakdown beyond "professionals" was made by the test administrators, so neither the number of engineers nor their normative means are available (29). The BCE civilian engineers' mean MPS (as a collective group) was then contrasted against the MPS from VanMaanen and Katz' "professional" group. However, as is explained in Appendix D, a direct comparison of the two groups was not possible without recalculating the BCE civilian engineering group's MPS value.

The second method of comparison for this research hypothesis came from the JDS normative data tables compiled by Oldham, Hackman, and Stepina in 1978. The JDS here was administered to 6,930 employees working on 876 different jobs in 56 organizations throughout the United States. The

jobs, taken from a highly heterogenous sample, were stratified into relatively homogenous groups. One of these stratified groups, "professional or technical," contained engineers. This stratified group comprised 8.2 percent of the jobs sampled in this research. As in the VanMaanen and Katz study, no breakdown of solely "engineers" was available from this study. The normative data included both means and standard deviations for the several Job Characteristics Model constructs measured. Hackman and Oldham suggested that in making comparisons, a difference between group norms of one standard deviation or less represented an insignificant difference. A difference of two or more standard deviations, however, signaled a significant difference between the normative base and the focal norm (BCE civilian engineers) (15:316; 31:10; 34).

The final method of comparison for this research hypothesis was the research work of Hanby and Zimmerman on civilian Air Force auditors in 1981. Hanby and Zimmerman performed a census upon the civilian Air Force auditor population of 577 and received 432 responses, a 75 percent participation rate. Auditors may be classified as "professionals" in VanMaanen and Katz' group stratification, and the General Schedule grades of these auditors is very similar to that of BCE civilian engineers (11:82; 17:63-64). For these reasons, comparisons between the two groups were assumed to be valid.

Research Objective Two was evaluated by the same three methods of comparison as was the first research hypothesis. Research Objective Three used only the normative means of the VanMaanen and Katz, and Hackman and Oldham studies for comparisons. The Auditor research did not measure the Growth Needs Strengths of its respondents.

<u>Research Objectives Four through Seven</u>

The data analysis for the final four research objectives was accomplished in several steps. The first step tested the normality and variance equivalence assumptions made earlier in this chapter. To do this, the Kolmogorov-Smirnov Goodness-of-Fit test and Cochran's C-test of Variance Homogeneity were performed upon the data. If both of these assumptions were found to be valid, two parametric statistical tests--Oneway Analysis of Variance and Duncan's Multiple Range test--were conducted upon the sample data. If either of the two assumptions were shown to be incorrect, a third step--two nonparametric tests similar to the Oneway and Duncan procedures (the Kruskall-Wallis H-test and Dunn's Multiple Comparisons test)--analyzed the data in lieu of the parametric tests. The last four research objectives, then, were analyzed using either parametric or nonparametric statistical tests, whichever applied in that instance.

Kolmogorov-Smirnov goodness-of-fit test and Cochran's C-test of variance homogeneity. The underlying assumptions of normality and equal variance were first tested. To test the data's probability distribution, the Kolmogorov-Smirnov Goodness-of-Fit test (K-S test) was conducted. The equal variance assumption was evaluated via the Cochran's C-test of Variance Homogeneity, which is an output of the Oneway subprogram described in the next section of this chapter.

The K-S test is a goodness-of-fit measure. It evaluates the sampled data and compares its probability distribution against theoretical population distributions. This determines whether the data could have reasonably come from one of three theoretical probability distributions (either uniform, Poisson, or normal). (22:224)

All experiments of this type were analyzed in the following manner:

H_o: The probability distribution for one of the measured constructs is approximately normal.

vs. H_a: The probability distribution is not approximately normal.

Rejection region: Reject H_o if $T > W_\alpha$

where: T = Maximum Absolute Difference between a normal probability distribution and the actual probability distribution, and

W_α = The Lilliefors test statistic. At $\alpha = 0.10$ for a sample size greater than 30, $W_\alpha = (.805)/(\sqrt{n})$ (n = sample size)

For a sample size of 385 yielding a 90 percent confidence interval, $W_\alpha = 0.0425$. Therefore, if the K-S test

revealed a T-value less than 0.0425, the data was assumed to be normal; if hte T-value was greater than 0.0425, the data could not be assumed to be normal. If the latter was the case, use of the parametric Oneway and Duncan tests was inappropriate and nonparametric tests were used instead.

Cochran's C-test of Variance Homogeneity, as the name implies, evaluates sample data to determine if the sampled variance is approximately equal to its population's variance. This test was accomplished using the Oneway subprogram which is described later in this chapter.

All experiments of this type were analyzed in the following manner:

H_o: The variance of the sampled factor's measure is approximately equal to that of the overall sample.

vs. H_a: The variance of the sampled factor's measure differs significantly from that of the overall sample.

Rejection region: Reject H_o if $\alpha > p$

where: α = Level of Significance, and

p = Experimental Significance

If the p-statistic was greater than 0.10, equal variances of the treatment were assumed. If the p-statistic was less than 0.10, the equivalence of the sample and population variances of the treatment could not be assumed and parametric testing was not appropriate. If the latter was the case, nonparametric tests had to be used instead of the Oneway and Duncan procedures.

Oneway analysis of variance and Duncan's multiple range test. The Oneway subprogram of SPSS provided a one-way analysis of variance of the several BCE civilian engineering positions (28:398). The Oneway subprogram tests a randomized design experiment. Such an experiment employs independent random samples to compare more than two treatment means. (27:459) A treatment may be thought of as a subunit of one of the analyzed factors. For instance, "Deputy BCEs" and "Design Engineers" were treatments of the independent variable "Position." For each treatment, the means evaluated were the five Job Characteristics Model (JCM) constructs as well as the MPS and GNS measures. The F-statistic was used to test if the treatment means differed significantly.

Experiments of this type were analyzed in the following manner:

H_o: All treatment means are approximately equal.

vs. H_a: At least two treatment means are significantly different.

Reject H_o if $F_{experiment} > F_{\alpha,(k-1),(n-k)}$

where: α = (1 - confidence interval)
k = number of treatments
n = sample size

The $F_{\alpha,(k-1),(n-k)}$ value was determined from standard F-distribution tables. If the experiment revealed an F-statistic greater than 1.67 (the critical tabulated F-statistic for this experiment), H_o was rejected and H_a was

accepted, lending support to the proposed research hypothesis. If the experiment's F-statistic was less than 1.67, H_o could not be rejected and no support was given toward the proposed research hypothesis.

The Oneway subprogram also prints the treatment's (or "group's") mean, standard deviation, and other information, but does not reveal which treatment mean differs significantly from other treatments. To determine this information, an "a posteriori" contrast test of the Oneway subprogram (i.e., Duncan's Multiple Range test) was used.

An a posteriori contrast test such as Duncan's test compares all possible pairs of treatment means. The treatments were divided into homogenous subsets in which the difference between any two treatment means was not significant at some prescribed α-level. This test enabled the research hypothesis to be evaluated more fully to determine where statistical differences lay. When parametric testing was found to be appropriate, then Duncan's test revealed if a significant difference existed between two or more groups.

Kruskall-Wallis H-test and Dunn's multiple comparisons test. In the event the parametric assumptions were not upheld for any variables evaluated, nonparametric statistical tests were performed instead. Nonparametric tests are not as informative as their parametric counterparts. Whereas parametric testing can identify statistical differences between treatment means, nonparametric testing can only infer

significant statistical differences between treatment probability distributions. While the latter information is not as revealing, it does lend some insight into making comparisons between two or more treatments.

The first such nonparametric statistical test used, the Kruskall-Wallis H-test, conducted a randomized design experiment similar to the Oneway test upon two or more samples. Use of the Kruskall-Wallis test (K-W test), however, required no assumptions about the sample's data normality or variance equivalence in comparing two or more treatments. The K-W test ranked each respondent's observation for one dependent variable (GNS, MPS, etc.) against all other similar observations. Ties were handled by assigning the average value of the ranks to each of the tied observations. The rank sum was computed for each treatment and the K-W H-statistic was compiled from these sums for each group. This H-statistic has approximately a chi-square distribution. (22:237; 27:501)

All experiments of this type were analyzed in the following manner:

H_o: All "k" treatments have approximately identical probability distributions.

vs. H_a: At least two treatments' probability distributions significantly differ.

Rejection region: Reject H_o if $H > X^2_{\alpha,d.f.}$

where: H = computed H-statistic, and

X^2 = tabulated chi-square statistic at $(1 - \alpha)$ confidence interval and $(k - 1)$ degrees of freedom

The "position" variable had nine different treatments. Therefore, the chi-square statistic at the $\alpha = 0.10$ level was tabulated at 13.4. The "age" and "grade" variables, with five and four treatments, respectively, used chi-square statistics of 7.78 and 6.25. These were the values which were compared against the computed H-statistic. In all comparisons, whenever the tabulated statistic exceeded the computed value, the null hypothesis could not be rejected. This indicated approximately identical probability distributions of all treatments. If, however, the experiment's H-statistic was greater than the tabulated value, the null hypothesis was rejected. In rejecting the null hypothesis, support was given to the notion of significant inequality between at least two treatments' probability distributions. In order to determine where the specific differences lay, the Multiple Comparisons test was employed.

Dunn's Multiple Comparisons test permits a simultaneous statement of differences between two or more treatments of an independent variable. These differences may be made at a single overall level of significance. (10:182) As the number of comparisons increases, the test becomes more powerful in detecting significant differences between two treatments (24:93). An α-level of 0.10 was used in the Multiple Comparisons test. Dunn's test used the group mean ranks derived from the Kruskall-Wallis procedure. The difference between treatments' overall rank sums was then

compared against a tabulated figure derived from a standard normal distribution, number of respondents, and treatment size. Procedures for establishing Dunn's Multiple Comparisons test (which is not a computerized routine of SPSS) are explained in Appendix G.

CHAPTER 4

DATA ANALYSIS

Introduction

This chapter details the procedure of data accumulation, the survey response rate, and the method of measuring the several variables. The concluding section of this chapter is divided into two distinct parts. The first part presents the results of tests evaluating Research Objectives One through Three. These tests were accomplished simply by comparisons with prior research employing the Job Diagnostic Survey upon similar groups as BCE civilian engineers. The second part evaluates the last four research objectives. This part presents the validation of two key assumptions about the data and describes the results of either the parametric or nonparametric statistical tests upon the collected observations. These latter tests have been broken down by research objectives.

Data Collection

A total of 485 surveys were mailed to the 71 CONUS Air Force Bases on 19 May 1982. Each Base Civil Engineer was sent a package of several surveys and an instruction letter explaining distribution. Every survey had a self-addressed, pre-postage metered return envelope attached to

it. The first returned surveys arrived only two days after mailing; the last returned survey arrived on 25 June 1982. A total of 368 surveys were returned of the 485 originally mailed. No follow-up on survey return was attempted. Four of the returned surveys were unanswered and six were only partially completed (and therefore disregarded). Therefore, 358 surveys were available for data analysis, representing a 73.8 percent return rate.

As explained in Chapter 3, at least 385 responses were required to achieve a 95 percent degree of confidence for the research findings. Since the response fell short of this number, only a 90 percent confidence interval (using all 358 returned surveys) was employed. All statistical findings made in this chapter reflect this 90 percent degree of confidence.

Data Analysis: Research Objectives 1-3

The nonstatistical group mean comparisons detailed in Chapter 3 were used for data analysis covering the first three research objectives. These three objectives were evaluated via seven research hypotheses. Sequencing of the hypotheses essentially follows the pre-application evaluation of the subject group as outlined by Hackman and Oldham. This section explains the results of these hypohteses derived from the sample population.

Research objective one.

Determine the feasibility of applying job enrichment techniques to BCE civilian engineers.

Research Hypothesis One was formulated to fulfill this objective:

> The MPS of BCE civilian engineers is greater than or equal to that of other similarly structured groups (as measured by previous research employing the Job Diagnostic Survey).

A job which has a relatively high MPS creates conditions which internally reward the jobholder for performing well. A job which scored relatively high in MPS, then, indicated that job enrichment techniques were not needed as badly as in a relatively low-scoring MPS job.

The lowest possible MPS is 1 and the highest possible score is 343. As explained more fully in Appendix D, MPS values can be computed in two different ways. Hackman and Oldham report that an average MPS for jobs in American businesses is about 128 (15:82). The BCE civilian engineer group displayed a collective MPS of 160.4597 using the scoring method recommended by Oldham (30). This score is larger than Oldham, Hackman, and Stepina's "professional or technical" job category, which scored 154, and considerably larger than Hanby and Zimmerman's auditors who had an MPS of 108.386. VanMaanen and Katz' "professional" job category scored a collective MPS of 167. However, their method of tabulating MPS values differed from the procedure used in this research. By VanMaanen and Katz' calculations, BCE

civilian engineers would score 153.0378, lower than their "professional" group. Group comparisons are graphically shown in Figure 4-1.

Because these comparisons did not employ statistical methods, no probabilistic conclusions were made. However, some insight into the BCE civilian engineer environment may be obtained. At the least, BCE civilian engineers appeared to fall into the upper range of MPS scores as compared to similar job categories. The above comparisons indicated that Research Hypothesis One was true in most cases. The only comparison group with a higher MPS was VanMaanen and Katz' "professionals." This group, which contained doctors, lawyers and other jobs in addition to engineers, may have raised this group's MPS higher than that of an "engineer-only" group. Job enrichment techniques, therefore, would not appear to be able to cause BCE civilian engineer jobs to become more rewarding to jobholders.

Research objective two.

> *If job enrichment is determined to be a feasible approach, determine the specific core job dimensions which need to be dealt with to motivate these engineers.*

Job enrichment was determined not to be a feasible technique to be applied to BCE civilian engineers as a group. Therefore, examining Research Hypothesis Two, which compares BCE civilian engineers' five core job dimensions with that of similar job categories, would serve no purpose in Hackman and Oldham's job redesign procedure. However, the tables

LEGEND: 1 = VanMaanen and Katz' "Professionals"
2 = BCE Civilian Engineers (recalculated - see App. D)
3 = Hackman and Oldham's "Professional or Technical"
4 = BCE Civilian Engineers
5 = Hanby and Zimmerman's "Auditors"

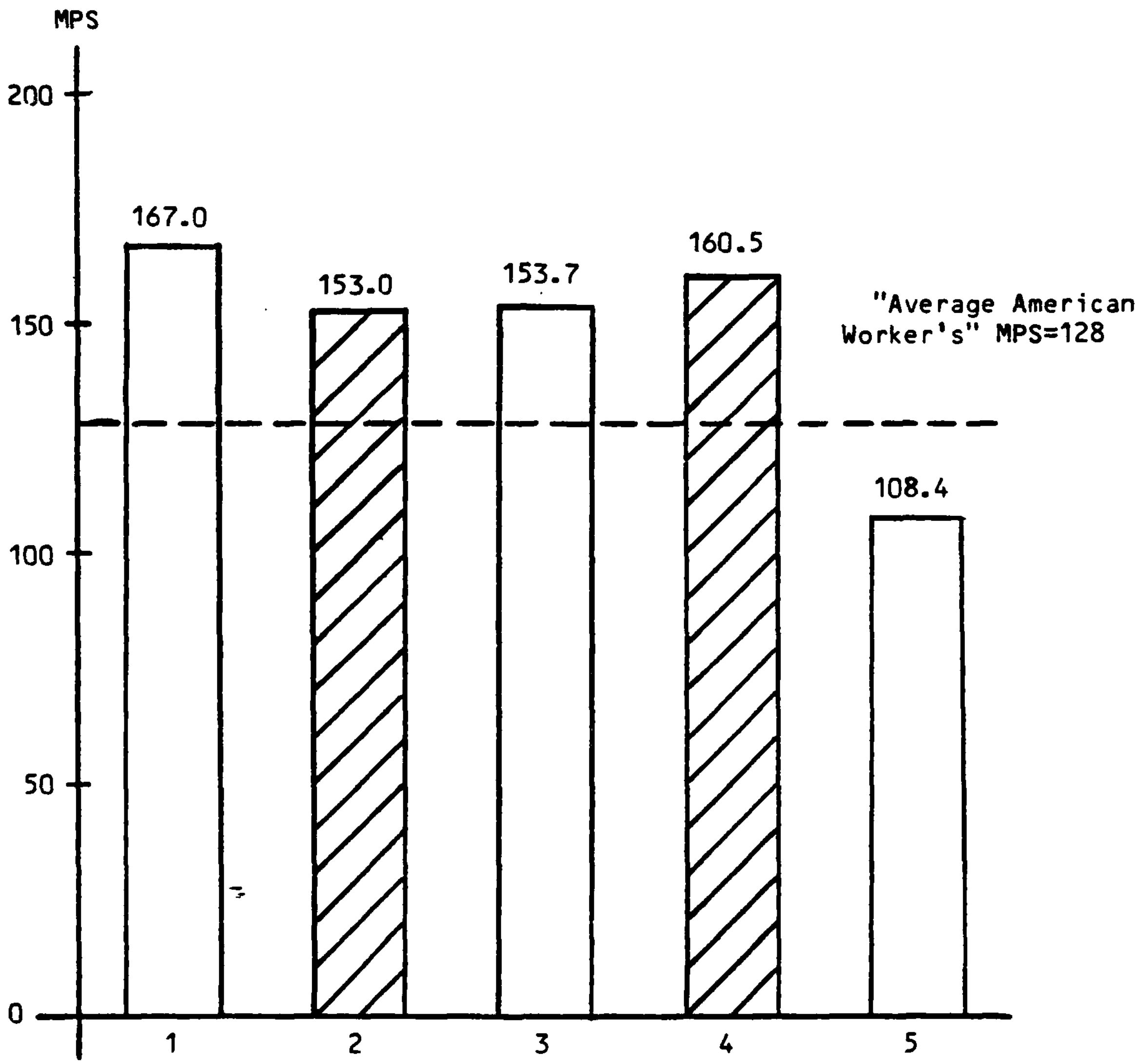

Figure 4-1. Groups Comparisons of MPS Values

in Figure 4-2 present a graphical comparison of BCE civilian engineers' core job dimension score with previous measurements of similar jobholders.

All of the Job Characteristics Model core job dimensions have a minimum possible score of 1 and a maximum of 7. Hackman and Oldham report the following as an "average" American worker's core job dimension measurements: Skill Variety = 4.7; Task Identity = 4.7; Task Significance = 5.5; Autonomy = 4.9; Job Feedback = 4.9 (12:105). A higher measurement by a group in any of the five variables signified that the employee group felt relatively satisfied in that particular core job dimension. Conversely, a lower score indicated that, from the respondents' viewpoints, room for improvement may exist in that dimension.

The figures show that, in each core job dimension, VanMaanen and Katz' "professionals" scored higher than BCE civilian engineers. The same argument may be brought against VanMaanen and Katz' group as was made in their MPS measure. A nonhomogenous group as this group may have caused its core job dimension measurements to be higher than would an "engineer-only" grouping.

By contrast, BCE civilian engineers scored higher in all but one core job dimension (Task Significance) when compared to Air Force civilian auditors. When compared to Oldham, Hackman, and Stepina's "professional or technical" category, BCE civilian engineers scored higher in three

LEGEND: Group 1 = BCE Civilian Engineers
Group 2 = VanMaanen and Katz' "Professionals"
Group 3 = Oldham, Hackman and Stepina's "Professional or Technical"
Group 4 = Hanby and Zimmerman's "Auditors"

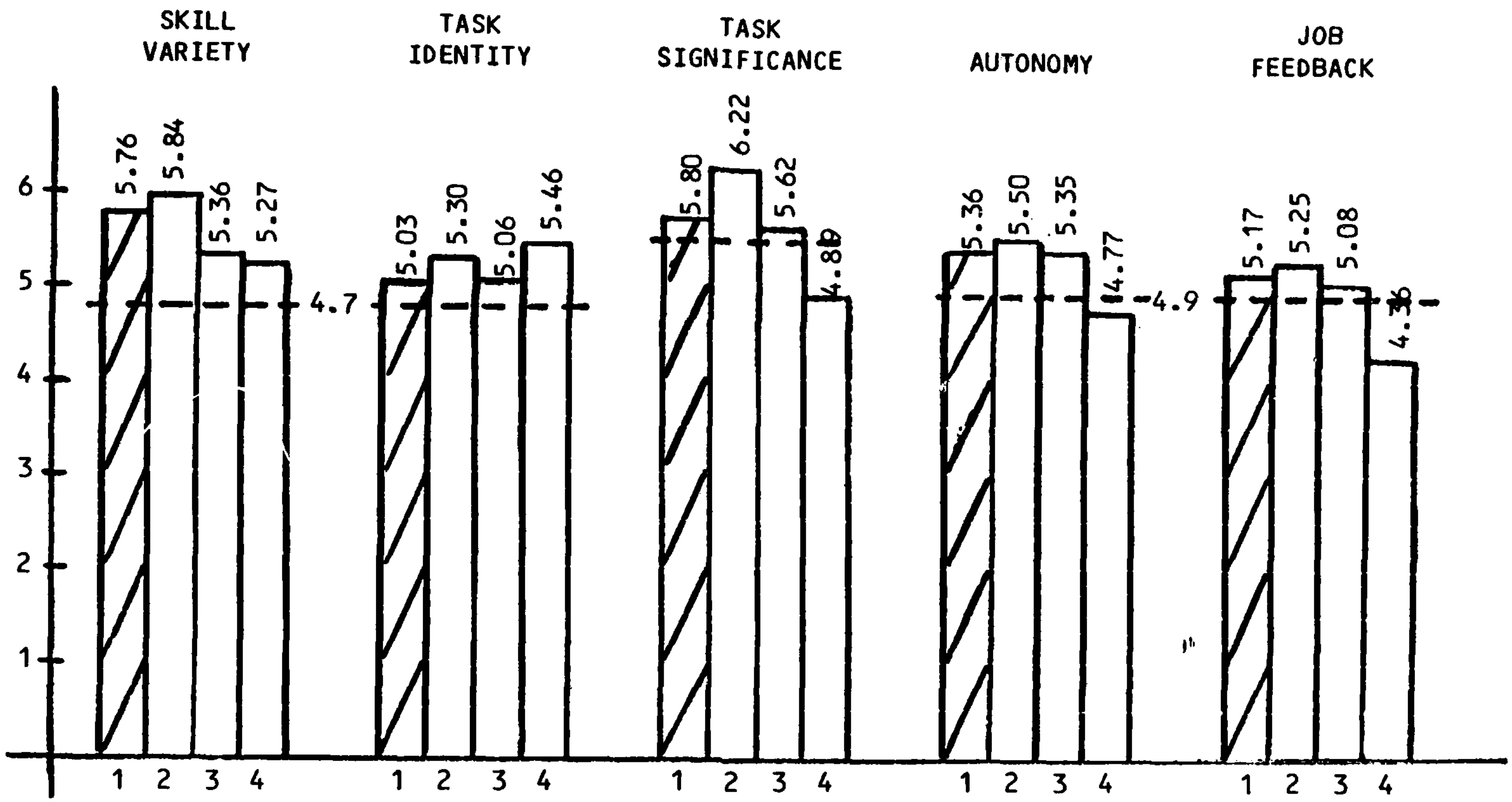

Figure 4-2. Group Core Job Dimensions Comparison

core job dimensions (Skill Variety, Task Significance, and Job Feedback), and lower in the other two (Task Identity and Autonomy). In none of these comparisons with Oldham, Hackman, and Stepina's group, however, did the two groups differ by more than one standard deviation. Accordingly, it cannot be concluded that significant differences existed between groups, although some comparative differences were apparent.

Although the comparison results were split for all five core job dimensions, BCE civilian engineers seemed to score nearly as high or higher than their counterparts in the areas of Skill Variety and Job Feedback. For the other three dimensions, however, no such pattern could be obtained from the comparisons. Although job redesign was shown not to be needed for BCE civilian engineers, improvements in the engineer group's motivation may be made by addressing the job's Task Identity, Task Significance, and Autonomy.

Research objective three.

> *Evaluate the potential reception of job enrichment efforts to civilian engineers in BCE organizations.*

This research objective was to be examined through the use of Research Hypothesis Three:

> The GNS measure of BCE civilian engineers is higher than the corresponding measure of other groups.

Growth Needs Strength scores may range from a maximum of 7 to a minimum of 1. The "average American worker" GNS values is 5.0 (12:105). Information about the respondent

may be obtained from the relative size of the GNS score. Jobholders with relatively high GNS scores were more likely to positively receive efforts to redesign their jobs than were those with relatively low GNS scores. Success of a planned job redesign effort is therefore higher upon jobholders scoring high in the GNS measurement.

Group Growth Need Strength measures are shown in Figure 4-3. Comparisons could only be made against two of the three previous studies as Hanby and Zimmerman did not measure the GNS measures of auditors. In the two available comparisons, BCE civilian engineers scored higher (5.9898) than both VanMaanen and Katz' "professionals" (5.86) or the "professional or technical" category of Oldham, Hackman, and Stepina (5.6). The BCE civilian engineers, however, did not score significantly higher than the latter group. Despite the fact that a "significant" difference could not be detected, BCE civilian engineers scored highly in this measure, lending support to Research Hypothesis Three.

These comparisons revealed that the potential reception by BCE civilian engineers of job redesign efforts is promising, despite a relatively high overall MPS value. This suggested that although BCE civilian engineers did not strongly feel that their jobs required the application of job enrichment techniques, such efforts would be positively received by them.

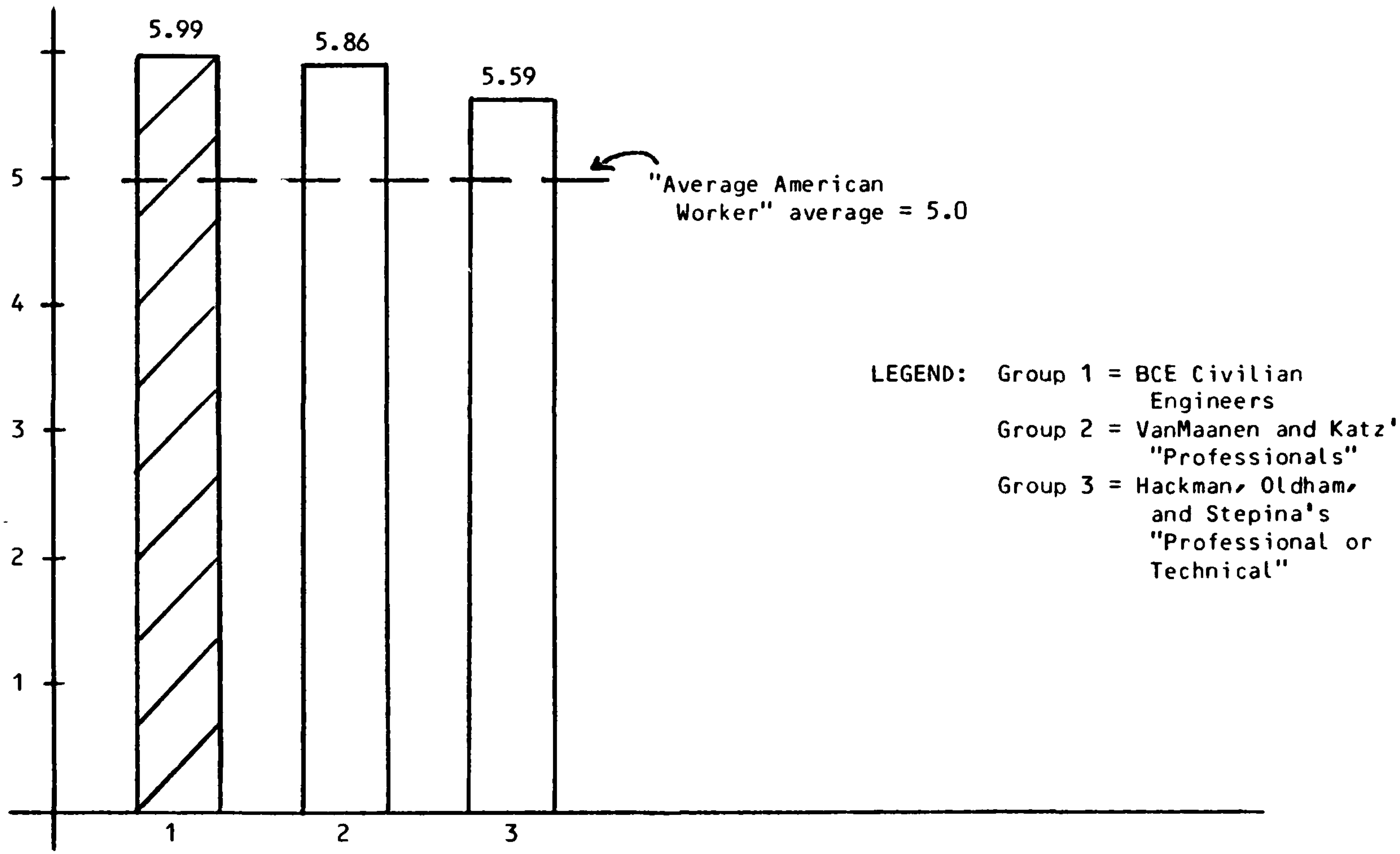

Figure 4-3. Group GNS Comparison

Data Analysis: Tests of Assumptions

Before the final four research objectives could be analyzed, two tests were performed upon the data to determine if the assumptions of normality and equal variance were valid. The Kolmogorov-Smirnov Goodness-of-Fit test evaluated the first assumption, and Cochran's C-test of Variance Homogeneity was used to validate the second assumption.

Tests for normality. To test for the normality of the data, the Kolmogorov-Smirnov test was performed upon all five of the Job Characteristics Model core job dimensions as well as upon GNS and MPS values. All 358 observations were used in evaluating these seven tests.

Results from the seven tests revealed that of the seven variables measured, only Motivating Potential Scores appeared to be approximately normal. For each of the other six variables, the null hypothesis was rejected, implying that their probability distributions were not normal. Output from these tests is displayed in Appendix E.

This finding severely limited the use of parametric testing upon the data. The only variable which could be evaluated via the Oneway/Duncan parametric procedures, then, was the MPS values. Cochran's C-test of Variance Homogeneity was next performed to determine which factors' MPS values could undergo parametric testing.

Tests for variance equivalence. Cochran's C-test was performed upon the MPS values for each of the three

factors (position, age, and grade). As with the K-S test, all 358 observations were used in performing Cochran's test.

Results from the three tests showed that, in MPS values, only two factors had approximately equal variances. These factors were "Position" and "Age." The other factor, "Grade," did not display approximate variance equivalence. Output from these tests is shown in Appendix F.

These findings further restricted which combination of variable-factor could be evaluated using the parametric Oneway/Duncan procedures. Only two combinations of MPS--with respondent's Position and Age--could be evaluated using parametric statistical tests. The other combination had to rely upon the nonparametric Kruskall-Wallis/Dunn procedures. Results of these specific tests are the subject of the rest of this chapter.

Data Analysis: Research Objectives 4-7

The final four research objectives examined within-group differences between two categories of the engineers themselves. All such comparisons were made using either parametric or nonparametric statistical tests, whichever was appropriate in that case. Detected differences were reported with a 90 percent degree of confidence employing all 358 usable replies.

Research objective four.

Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in all BCE civilian engineering positions.

Research Hypothesis Four was developed to evaluate this objective:

> The MPS/GNS measures of all BCE civilian engineering positions are approximately the same.

This research hypothesis had two distinct parts. The first part compared all nine positions' MPS values to detect if significant differences existed between them. The second part did the same for the nine GNS scores.

MPS by position. Motivating Potential Scores were discovered to have an approximately normal probability distribution. The probability distribution of the Position factor's MPS values had an approximately equal variance with the overall sample's MPS values. For these reasons, parametric testing was appropriate for the MPS--position combination. The Oneway and Duncan procedures, therefore, were performed here. Group means for MPS by Position are shown in Figure 4-4. The Oneway Analysis of Variance test upon this data revealed that the null hypothesis of approximate equality of the nine positions' MPS values should be rejected. Therefore, a significant difference was found to exist between at least two of the treatment means. Duncan's Multiple Range test was then executed upon the data to determine where this significance difference laid.

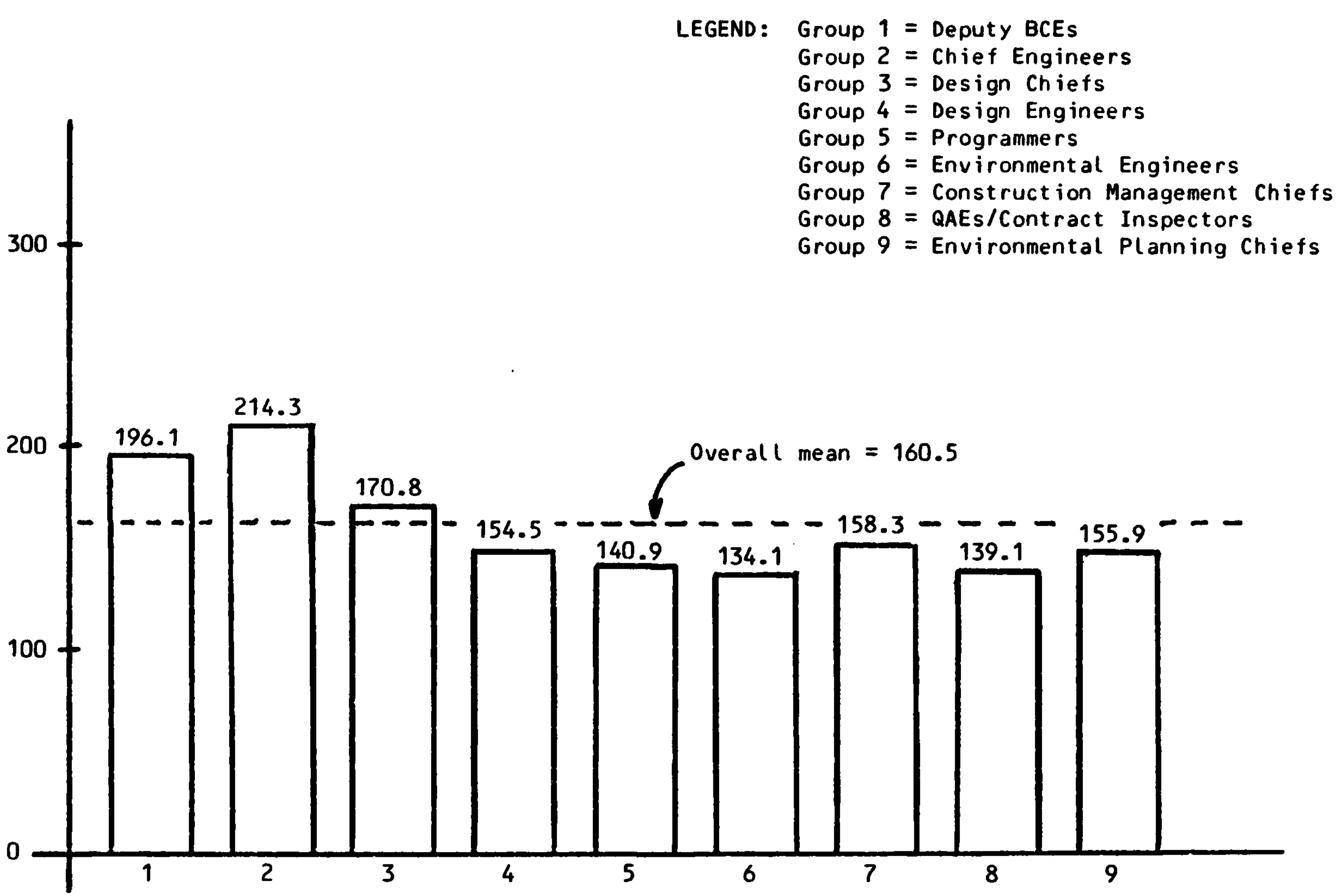

Figure 4-4. MPS Group Means by Position

Duncan's test showed that two homogenous subsets could be formed from the nine positions' MPS values. The higher-scoring subset consisted of three positions: Chief Engineers, Deputy BCEs, and Design Chiefs. The lower-scoring homogenous subset was composed of the remaining six BCE civilian engineering positions: Construction Management Chiefs, Chiefs of Environmental Planning, Design Engineers, Programmers, Quality Assurance Evaluators (QAEs)/Contract Inspectors, and Environmental Engineers. The computer output and subsequent data analyses for both of these tests is displayed in Appendix G.

The composition of the homogenous subsets, as well as the relative MPS rankings within, generally followed the decreasing grade/level of civilian engineers in BCE organizations. The only exception to this was the Environmental Engineer Group whose low MPS ranking did not correlate with their relative grade/level.

A second interpretation came from examining the subsets' compositions with respect to technical/managerial duties. The groups which measured the highest in the MPS evaluation were those positions (by virtue of their place in the BCE hierarchy) which were more managerial in scope. Incumbents in these three positions oversee the technical work of others rather than perform the technical work themselves. Jobholders here require more managerial abilities than do engineers in the other positions. The lower-scoring

positions in the MPS values were those engineers whose jobs require more technical than managerial abilities (although two of these positions were Section Chiefs). Overall, incumbents in these positions encounter predefined methods to accomplish their technical tasks, and they may find that decisions affecting their jobs are made <u>for</u> them instead of <u>by</u> them.

The data shows, then, that no support was given to the first part of Research Hypothesis Four. Significant differences did exist in the MPS values for the nine BCE civilian engineering positions. Further, it appeared from Duncan's test that introduction of job enrichment techniques would be more feasible upon the lower, more technically-oriented positions in the BCE hierarchy than upon the higher-echelon, managerial positions.

<u>GNS by position</u>. Unlike MPS values, Growth Need Strength scores did not display an approximately normal probability distribution. Nonparametric tests were performed to determine if significant differences existed between organizational positions..

Group mean ranks for GNS by Position are shown in Figure 4-5. These numbers represent the group's overall relative ranking against the other groups, but are not necessarily indicative of the group's mean. The Kruskall-Wallis test showed that, statistically, the GNS probability distributions of these nine positions were approximately

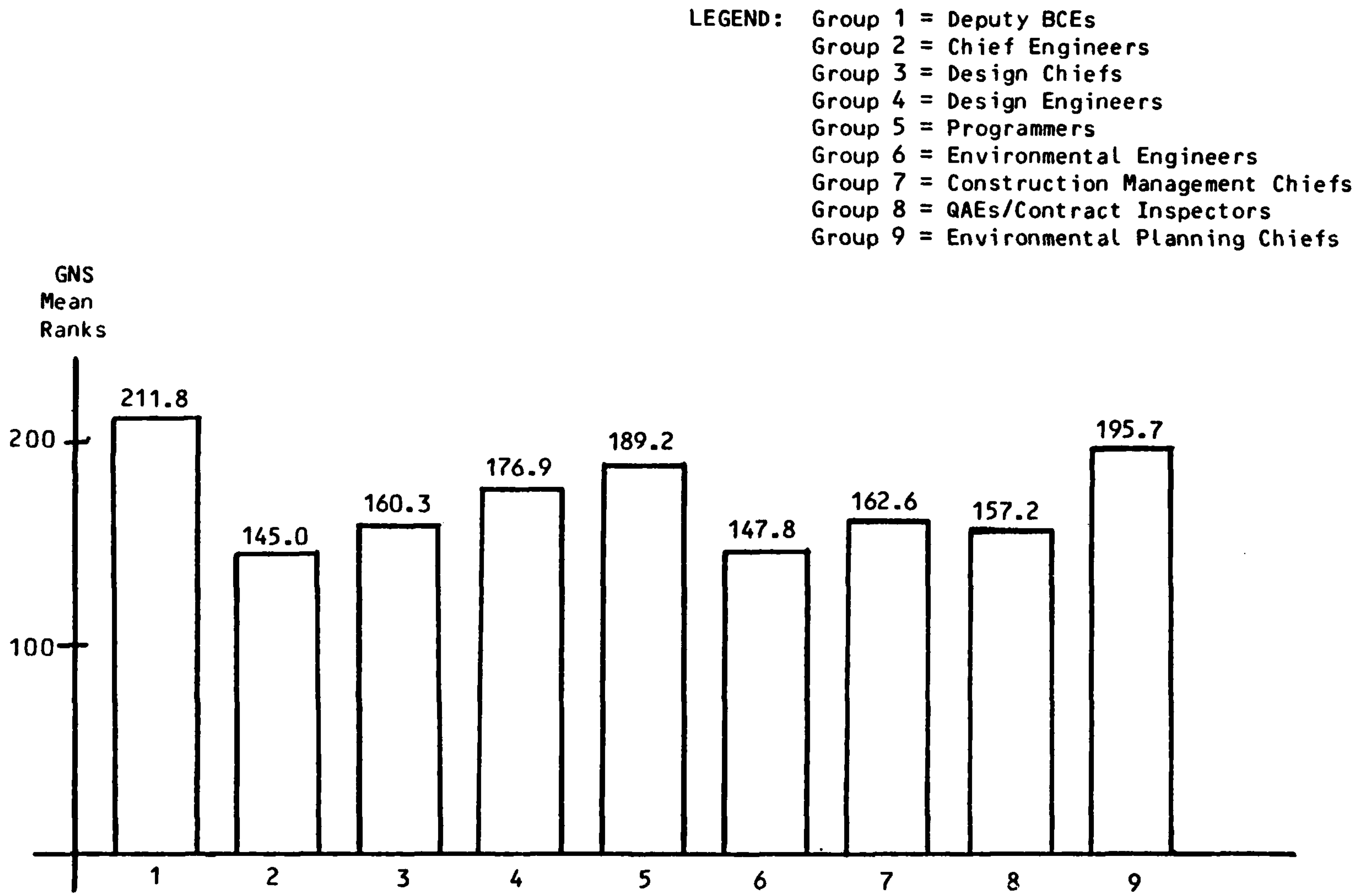

Figure 4-5. GNS Mean Ranks by Position

equal. Dunn's Multiple Comparisons test corroborated this finding by detecting no significant differences between any of the nine positions' rankings. Appendix H contains the computer and manual outputs which produced these results, as well as the data analyses performed.

The Growth Need Strength measure indicates the relative desire of engineers to obtain "growth" satisfaction from their jobs. The relative mean ranks of the nine positions did not seem to fall into an easily definable pattern. The highest-ranking positions (Deputy BCEs, Programmers, and Environmental Planning Chiefs) are dissimilar both by echelon within the BCE organization as well as by dominance of managerial/technical expertise required by the position. The same dissimilarities are found among the lowest-ranking positions (Chief Engineers, Environmental Engineers, and QAEs/Contract Inspectors). These test results indicated that the potential reception to job enrichment techniques were approximately equal among all BCE civilian engineering positions. This was true regardless of the hierarchy or grade/level of the position. This finding supported the latter half of Research Hypothesis Four.

Summary: research objective four. Analysis performed upon respondent's MPS and GNS values reveal split support for this research objective. Specifically, the feasibility of applying job enrichment techniques did not appear to be the same among the nine BCE civilian

engineering positions. The lower grade/level positions (with the exception of Environmental Engineers) seemed to be better suited to job enrichment techniques than did higher-echelon civilian engineers. On the other hand, potential reception to the application of job enrichment techniques did not significantly differ by position. All nine positions appeared to be equally receptive to the application of these techniques. Job enrichment application, if applied, would benefit some BCE civilian engineers more than others. Detrimental effects from this application, however, would not be anticipated.

Research objective five.

> *Determine if the core job dimension measures are approximately equal for all BCE civilian engineering positions.*

Research Hypothesis Five was developed to evaluate this research objective:

> The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineering positions are approximately equal.

The analysis of this hypothesis was divided into five parts, corresponding to each of the five core job dimensions evaluated. None of these job dimensions were found to have normally distributed probability functions. Therefore, the nonparametric Kruskall-Wallis and Dunn tests were used in their data analysis.

Skill variety. The group mean ranks for the nine positions' Skill Variety probability distributions are

shown in Figure 4-6. The Kruskall-Wallis H-test run on these data revealed that a significant statistical difference existed between at least two of the probability distributions. Dunn's Multiple Comparisons test was next used to identify the location of these differences.

Dunn's test identified seven significant differences between the positions' probability distributions. Five of these differences involved the Deputy Base Civil Engineer group. It was found that this group's probability distribution ranked significantly higher than that of Design Engineers, Programmers, Environmental Engineers, QAEs/Contract Inspectors, and Environmental Planning Chiefs. The last two significant differences detected by Dunn's test both involved the Programmer group. This group was found to have a probability distribution significantly lower than either the Chief Engineer or Design Chief groups. Specific computer and manual outputs of both tests and the data analyses employed are described in Appendix H.

The Skill Variety measure indicates the degree which the job requires incumbents to employ a number of their skills and talents in accomplishing their tasks. Results from these tests indicated that the highest three civilian positions in the BCE hierarchy (Deputy BCEs, Chief Engineers, and Design Chiefs) contained the greatest relative amounts of Skill Variety, particularly the Deputy BCE position. These positions necessarily require the jobholder to use

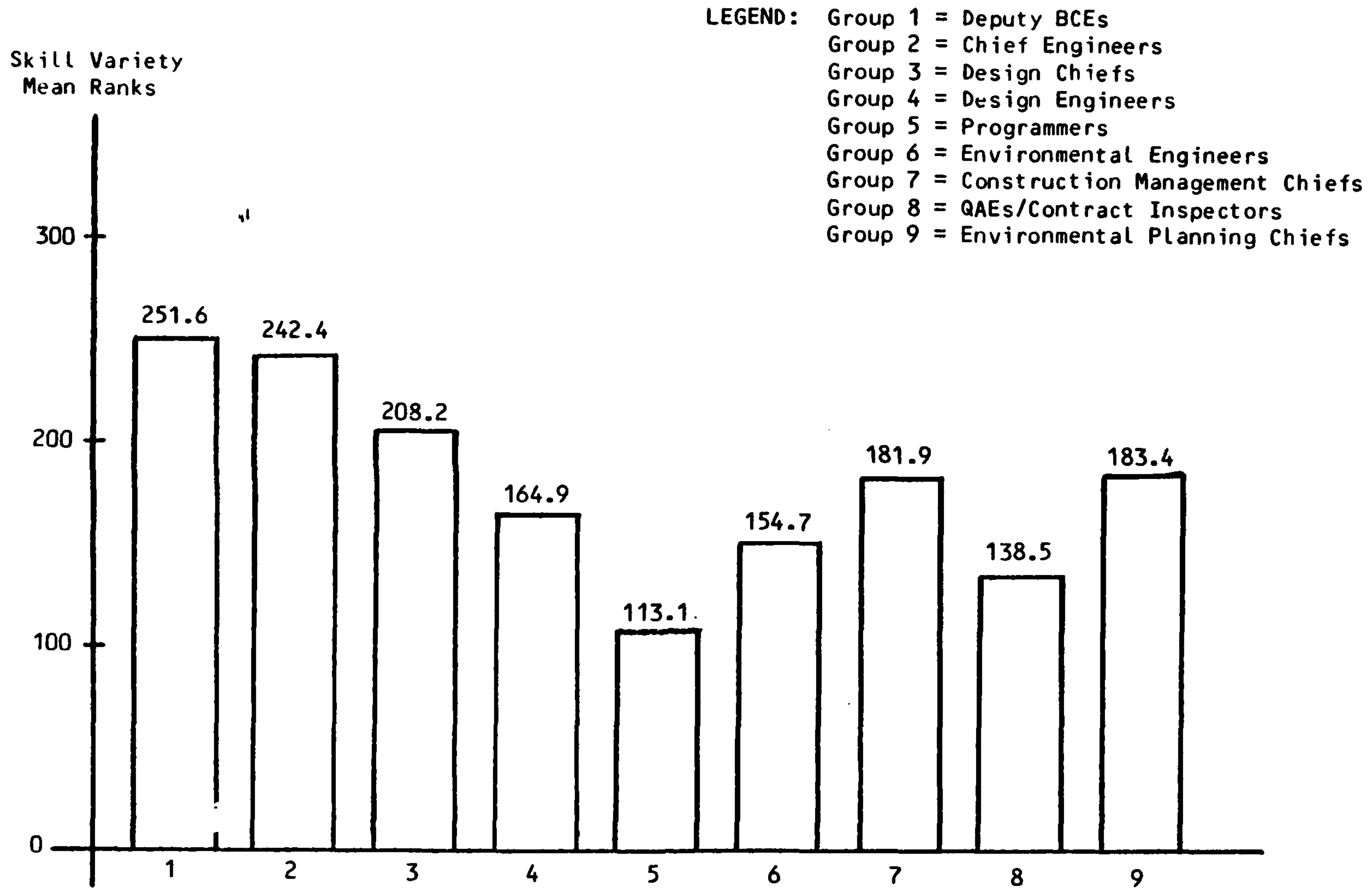

Figure 4-6. Skill Variety Mean Ranks by Position

more managerial skills and to become involved with a wider scope of projects than lower-echelon positions. Conversely, the positions with the least relative amount of Skill Variety (Porgrammers and QAEs/Contract Inspectors) were those lower in the BCE civilian engineer hierarchy. These jobs require incumbents to perform basically the same type of technical tasks daily with little change throughout a career. This is particularly true of the Programmer group. Therefore, this part of Research Hypothesis Five was not supported. Job enrichment techniques which offer greater amounts of Skill Variety should be aimed at the lower-echelon BCE civilian engineering positions which involve more routine daily job patterns.

Task identity. Figure 4-7 shows the group mean ranks for the probability distributions of the positions' Task Identity. The Kruskall-Wallis test, when run upon this data, showed that at least two of the nine probability distributions significantly differed. Dunn's Multiple Comparisons test identified that only one such difference existed: the Task Identity probability distribution of Design Engineers had a higher median value than that of Deputy BCEs. No other significant differences were noted from the comparisons. This was despite the fact that Chief Engineers had a higher group mean rank than did Design Engineers, and Environmental Planning Chiefs had a lower

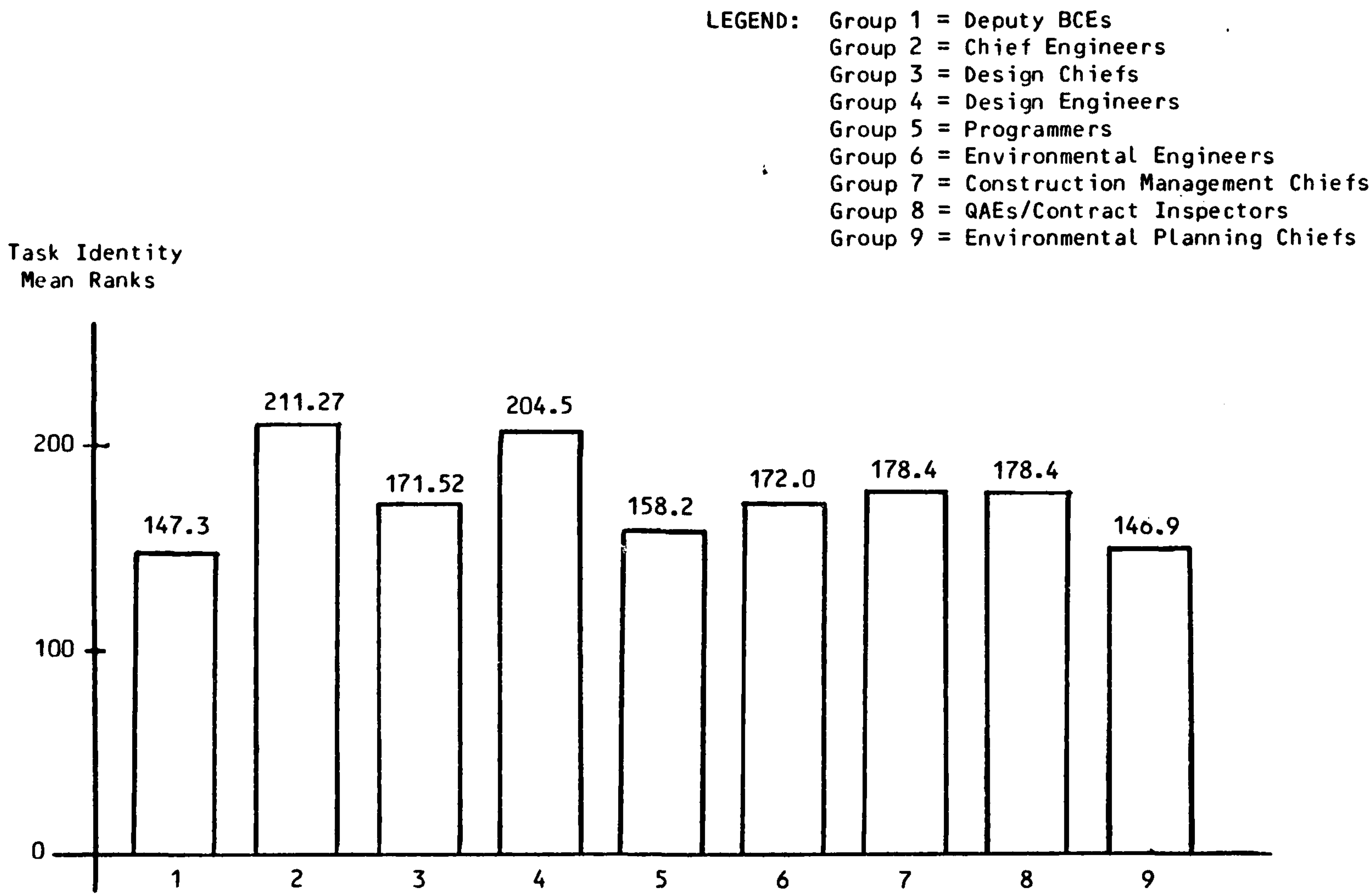

Figure 4-7. Task Identity Mean Ranks by Position

group mean rank than did Deputy BCEs. Computer and manual outputs and the resulting data analyses are shown in Appendix H.

The Task Identity measure indicates the degree which the employee feels his/her job involves full project participation from start to finish with a visible outcome. It was not surprising that the BCE civilian engineering positions which ranked highest in this measure were those involved with the design and construction of technical projects (Chief Engineers, Design Engineers, Construction Management Chiefs, and QAEs/Contract Inspectors). Those positions with relatively lower Task Identity rankings were those not involved with one specific project but rather with several concurrent projects (Deputy BCEs, Programmers and Environmental Planning Chiefs). As with the previous measure, this portion of Research Hypothesis Five was unsupported. If job enrichment measures geared to improve the Task Identity output of the job are to be employed, they should be aimed at those positions which require continual indirect involvement with several ongoing responsibilities.

Task significance. The group mean ranks for the positions' Task Significance measure are displayed in Figure 4-8. When performed upon the data, the nonparametric K-W test showed that not all nine positions' probability distributions were approximately identical. Dunn's test identified four significant differences in these probability

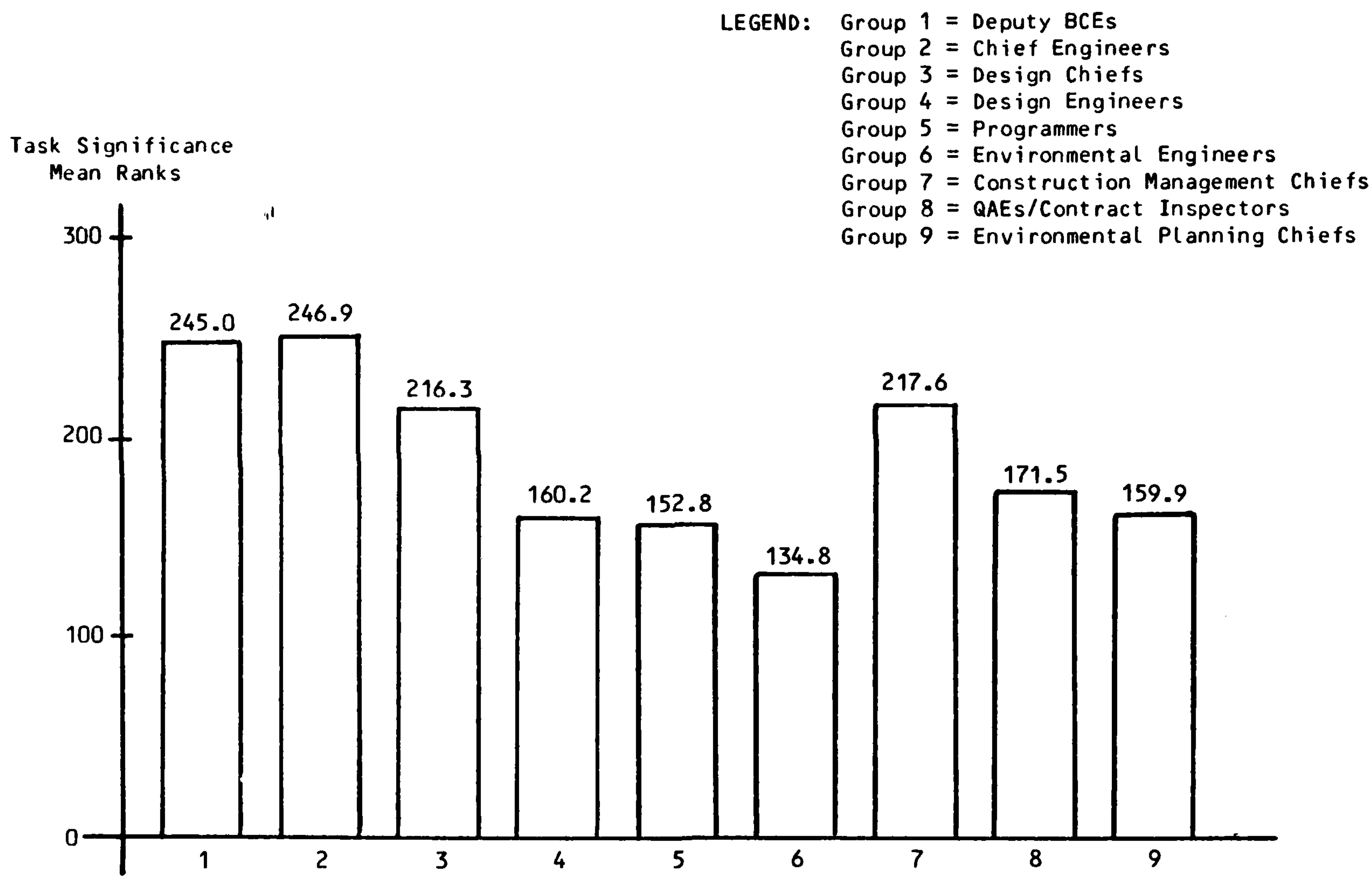

Figure 4-8. Task Significance Mean Ranks by Position

distributions. All four differences involved the Deputy BCE group. This group had a median ranking significantly higher than that of Design Engineers, Programmers, Environmental Engineers, and Environmental Planning Chiefs. The Chief Engineer group, which had a mean rank even higher than Deputy BCEs, did not demonstrate a significant difference with any other group (due to the low number of respondents in the Chief Engineer group). This variable's computer and manual analyses are shown in Appendix H.

The Task Significance measure indicates the degree that respondents believe their jobs substantially impact the lives or work of others. Findings of this test revealed that several BCE civilian engineering positions were perceived as having a good deal of impact upon job incumbents. This was particularly evident in the managerial positions (Deputy BCEs especially, but also Chief Engineers, Design Chiefs, and Construction Management Chiefs), with the exception of Environmental Planning Chiefs. The results also indicated that those BCE civilian engineers who were more involved with the technical aspects of the mission (i.e., Design Engineers, Programmers, and Environmental Engineers) found less Task Significance in their jobs. This portion of Research Hypothesis Five, then, was not supported. Job enrichment efforts affecting the employees' perception of Task Significance, therefore, are needed more in the technically-oriented positions.

Autonomy. The positions' mean rankings for the Autonomy measure are given in Figure 4-9. The Kruskall-Wallis test performed on this data detected the existence of at least one statistically significant difference in group probability distributions. Dunn's Multiple Comparisons test showed that three such differences could be noted. As with other variables, all three significant differences involved the Deputy BCE group. This group produced statistically higher-ranking probability distributions than those of Design Engineers, Programmers, and QAEs/Contract Inspectors. The computer and manual outputs and subsequent data analyses performed on the output are detailed in Appendix H.

The Autonomy measurement indicates the degree to which the job allows employees to schedule their own work and determine procedures to perform their tasks. The two positions which ranked relatively highest in this measure (Deputy BCEs and Chief Engineers) are at the top of the BCE civilian engineering hierarchy. By virtue of this, these positions presumably experienced more Autonomy in scheduling their tasks and assigning procedures for their work than did lower-echelon engineers. The three positions which ranked significantly lower in Autonomy (Design Engineers, Programmers, and QAEs/Contract Inspectors) were those for which supervisors oftentimes scheduled the work. These positions also typically have standardized, if not regulated, procedures to perform the work. This portion of Research

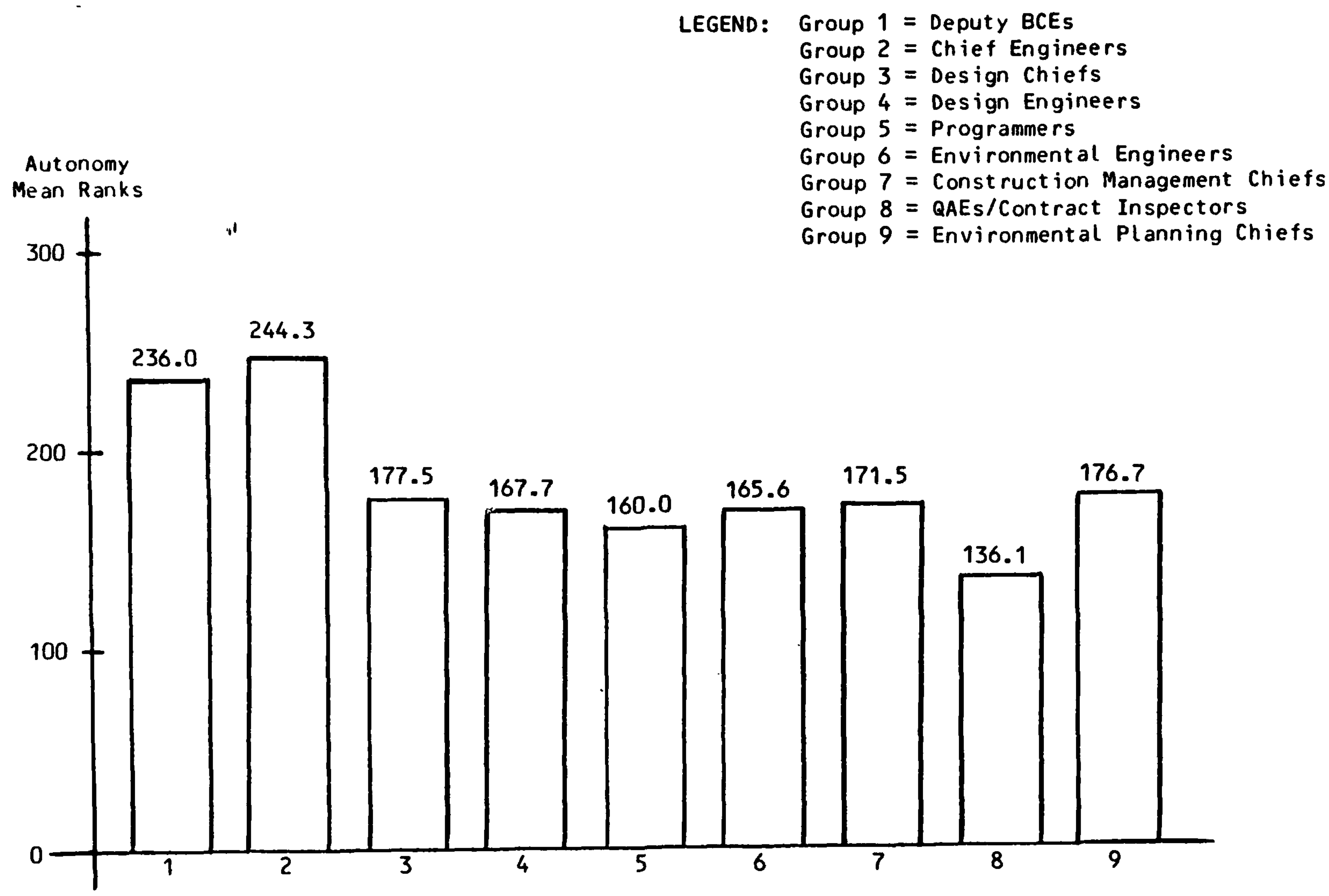

Figure 4-9. Autonomy Mean Ranks by Position

Hypothesis Five was not, therefore, supported. Significant differences did exist between the nine positions in the Autonomy measurement. Job enrichment applications which provide for improvement in the incumbent's Autonomy would prove beneficial for the "supervisor-scheduled" and "regulated" positions in the BCE organization.

<u>Job feedback</u>. The fifth and final dependent variable measured, Job Feedback, produced the group mean ranks shown in Figure 4-10. The Kruskall-Wallis H-test indicated that no significant difference existed among the mean ranks of these positions. Dunn's test lent further support to this notion by indicating statistically insignificant differences. The computer and manual outputs of this experiment, as well as their specific data analyses, are given in Appendix H.

The Job Feedback measure indicates how well performing the job yields direct information to engineers on the effectiveness of their performance. Despite the lack of statistical support, two items were noted from the relative rankings of the nine positions. First, the highest-ranking positions (Deputy BCEs and Chief Engineers) were also those at the top of the BCE civilian engineer hierarchy. Predictably, these positions received a good deal of feedback from performing their daily tasks through interactions with extra-organizational superiors. On the other hand, the position with the lowest relative ranking, Environmental Engineers,

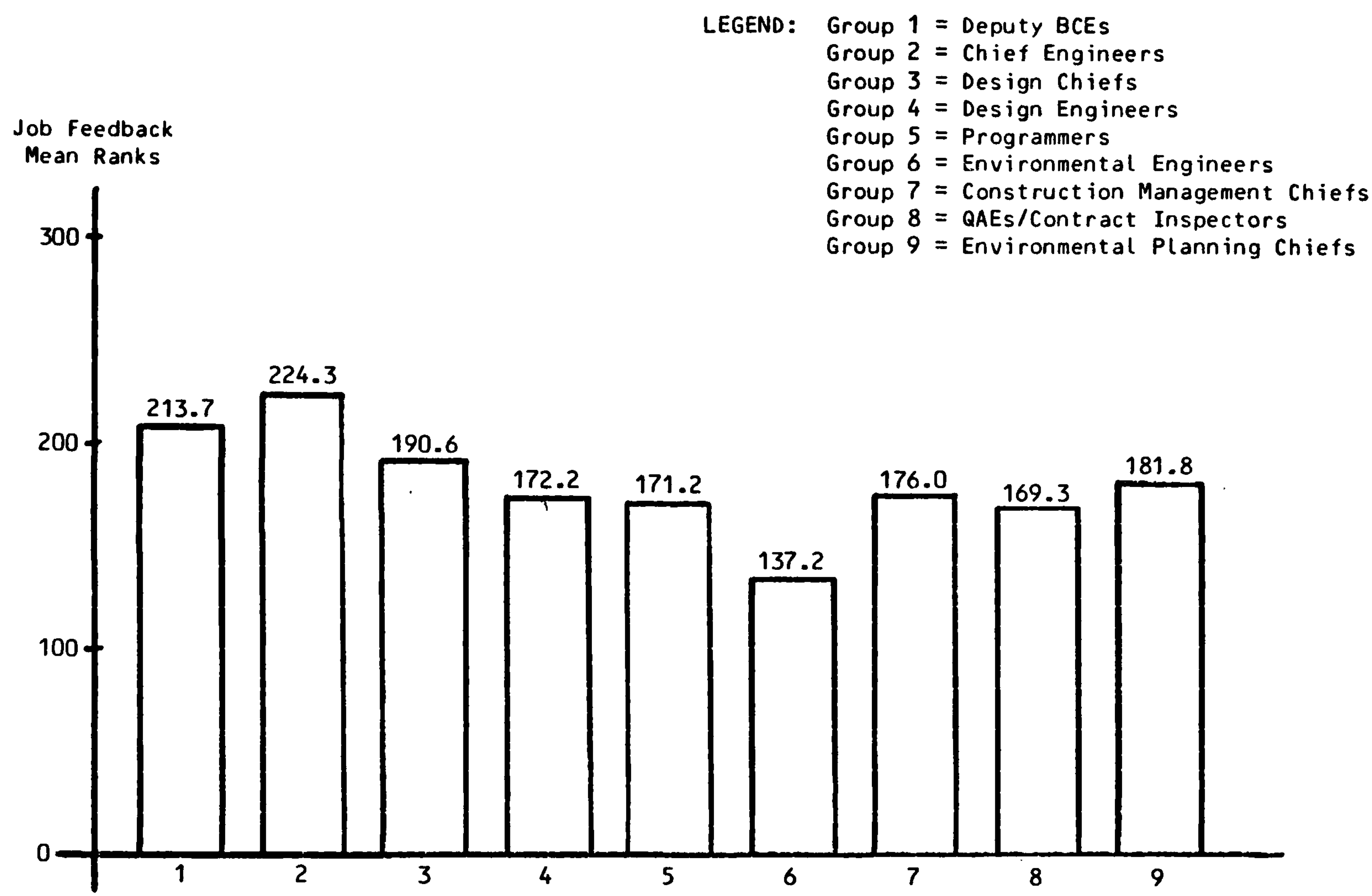

Figure 4-10. Job Feedback Mean Ranks by Position

operates in a largely undefined environment. Also, results of many of their actions may take a longer period of time to materialize. These facts may have caused such a low Job Feedback ranking.

However, from a statistical standpoint, this final portion of Research Hypothesis Five was supported. The nine positions rated approximately equal in the Job Feedback measurement.

Summary: research objective five. When stratified into subgroups of the Position category, the combined results of these five tests identified the engineer groups requiring job enrichment techniques the most. The stratifications were classified as either "Managerial" or "Technical" positions, depending both upon grade/level in the organization and type of duties assigned. The "managerial" subgroup consisted of Deputy BCEs, Chief Engineers, Design Chiefs, and Construction Management Chiefs. This group accounted for virtually all of the highest relative rankings in the five nonparametric tests. The "technical" subgroup (Design Engineers, Programmers, Environmental Engineers, QAEs/Contract Inspectors, and Environmental Planning Chiefs) accounted for nearly all of the lowest relative rankings. Based upon these findings, job enrichment techniques which would increase a position's Skill Variety, Task Identity, Task Significance, Autonomy, or Job Feedback were found to be best suited for the "technical" subgroup. Such techniques,

then, would be most beneficial to positions which are lower in the BCE hierarchy and which are more techncially oriented.

Research objective six.

> *Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in both categories (i.e., age and grade).*

Two research hypotheses were developed to evaluate this objective. Each hypothesis examined one of the two categories. Both of the research hypotheses were analyzed separately and are presented as such in this section.

Research hypothesis six. The sixth research hypothesis examined the MPS and GNS measures of the "Age" category. It read:

> The MPS/GNS measures of all BCE civilian engineers are approximately equal regardless of age.

Analysis of these two measures was accomplished by two distinct series of tests. The MPS values were found to be normally distributed (see Appendix E), and the Age probability distribution of MPS values was approximately equivalent to that of the overall sample (see Appendix F). For these reasons, parametric statistical procedures were appropriate on the "MPS-Age" combination. On the other hand, the GNS scores were not found to be normally distributed (see Appendix E). Therefore, only nonparametric procedures were applicable for the "GNS-Age" combination.

MPS by age. Group means for MPS values by Age are shown in Figure 4-11. The parametric Oneway procedure

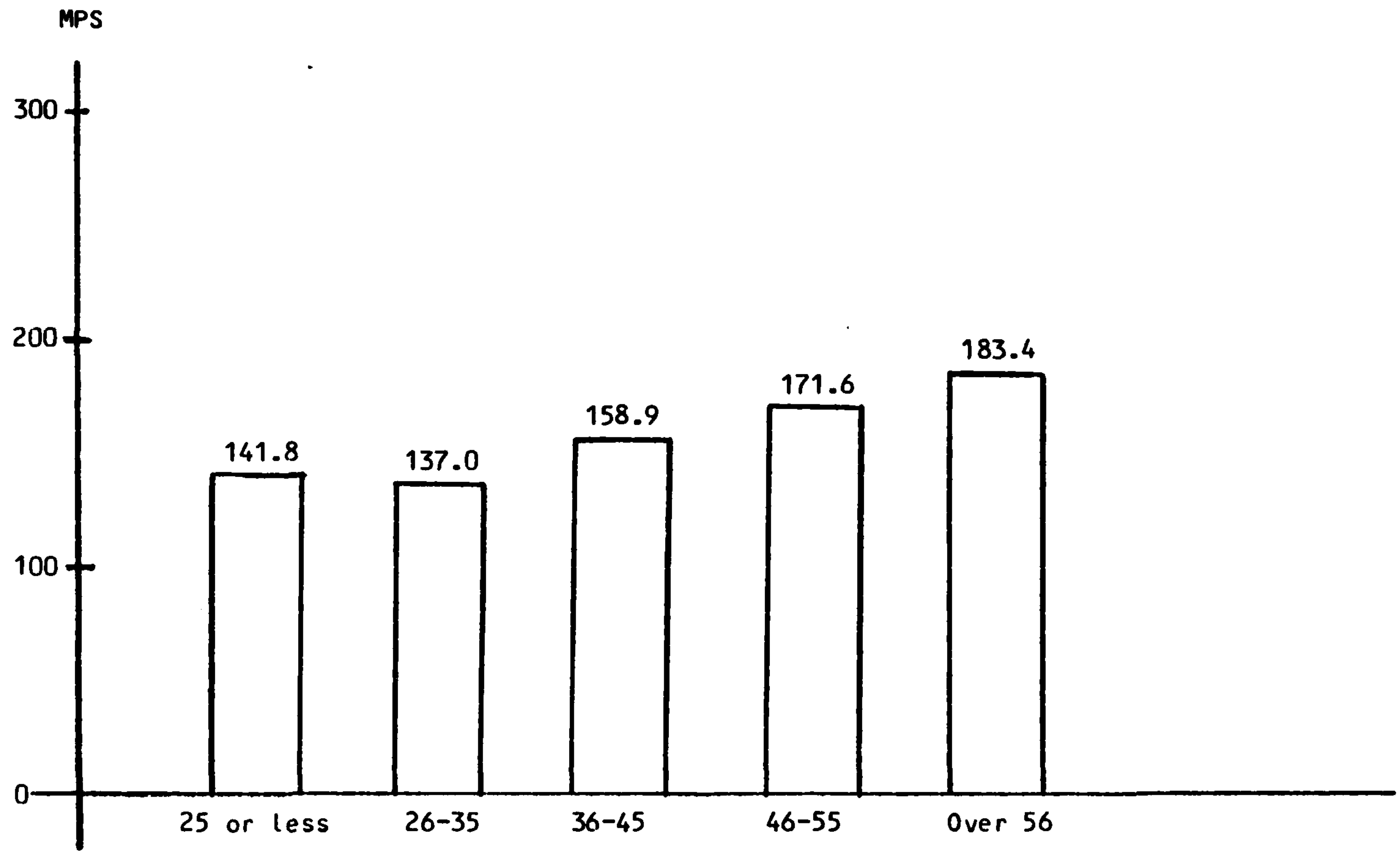

Figure 4-11. MPS by Age

evaluated this combination of variables. This test indicated that a significant difference existed between at least two treatment means. Duncan's Multiple Comparison test identified three homogenous subsets of MPS values. The highest scoring subset consisted of the two oldest groups (56 years old or more, and 46-55 years old). The middle subset contained two age groups (25 years old or less, and 36-45 years old). The lowest scoring group was the 26-35 years old group. Computer output and data analysis is detailed in Appendix I.

Motivating Potential Scores indicate the job's potential to positively motivate workers. Generally, MPS values increased as the age group increased, with the exception of the 26-35 category. This showed that the younger engineers received little internal motivation from accomplishing their jobs. This potential to motivate dropped further for the 26-35 category, then began to steadily rise until it reached its highest level for the 56-or-older category. The lowest potential to motivate affected those engineers who may be experiencing a "mid-career crisis": deciding to remain with the Air Force or to seek private employment. After the engineer decided to remain, the job's potential to motivate assumed its prior level and then increased with increasing age.

Data analysis, therefore, showed that the first part to Research Hypothesis Six was not supported.

Significant statistical differences existed between the five age groups. The group most in need of job enrichment techniques was the "mid-career crisis" group of 26-35 years old.

<u>GNS by age</u>. Group mean ranks for the five age categories is shown in Figure 4-12. The nonparametric Kruskall-Wallis and Dunn's tests were performed on this data. The K-W test indicated that no significant differences existed among the five categories. Dunn's Multiple Comparisons test supported the K-W finding of no statistical differences among age groups. Computer and manual outputs and analyses of these data are presented in Appendix I.

Figure 4-12 shows that GNS scores generally declined with increasing age. The GNS measure reveals the engineer's desire to obtain growth satisfaction from their work. The highest GNS occurred in the youngest age group (which was when MPS values were low), and was lowest in the oldest group (when MPS values were highest). Although no significant differences existed here, the point is worth noting. BCE civilian engineers have their greatest desire to grow from the job at a young age, at a time when their jobs do not positively motivate them. Conversely, when these engineers' jobs can positively motivate them, their desire to attain personal growth was lowest.

The second part of Research Hypothesis Six was statistically upheld. No significant differences existed

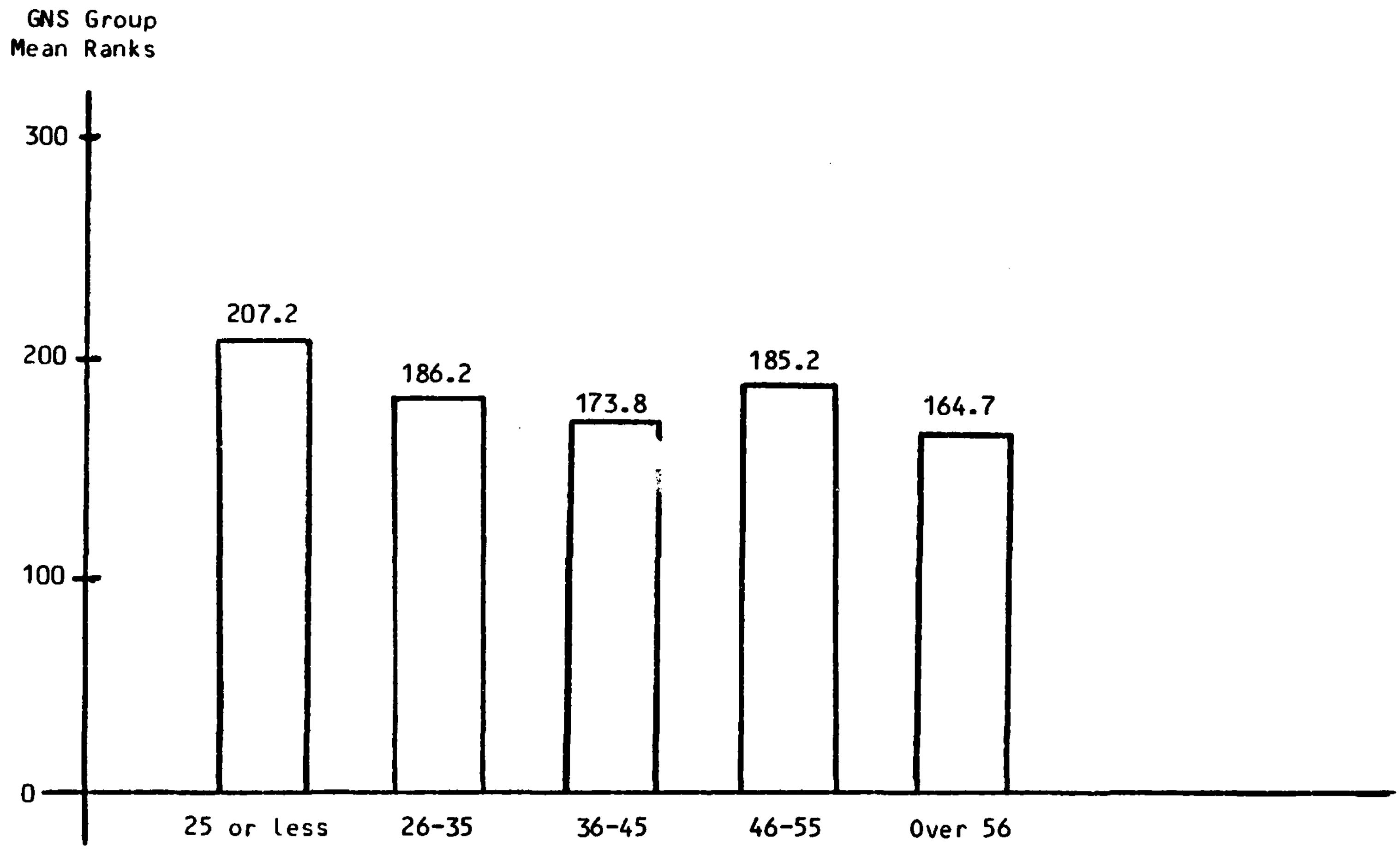

Figure 4-12. GNS Group Mean Ranks by Age

between the five age groups. However, numerical GNS differences were detected which correlated with MPS values. Job enrichment techniques, therefore, would be better received by the youngest engineers.

Research hypothesis seven. Research Hypothesis Seven was used to evaluate the second part of Research Objective Six, dealing with measurement categorized by respondent's grade. This hypothesis read:

> The MPS/GNS measures of all BCE civilian engineers are approximately equal regardless of General Schedule grade level.

As with the analysis of Age categories, the MPS and GNS values were analyzed using two distinct series of tests. Motivating Potential Scores, as previously explained, could have the parametric test procedures applied to them, provided that equal variances were found. This was not the case with the "MPS-Grade" combination. Therefore, parametric tests were not appropriate upon the several grades' MPS measurements. The same was true for GNS scores by Grades, but for a different reason. Here, the probability functions were not approximately normal. Hence, both dependent variables were analyzed using nonparametric techniques.

MPS by grade. Group mean ranks for MPS values by grade are displayed in Figure 4-13. Nonparametric statistical tests were performed upon this dependent variable because of unequal variances. The Kruskall-Wallis test

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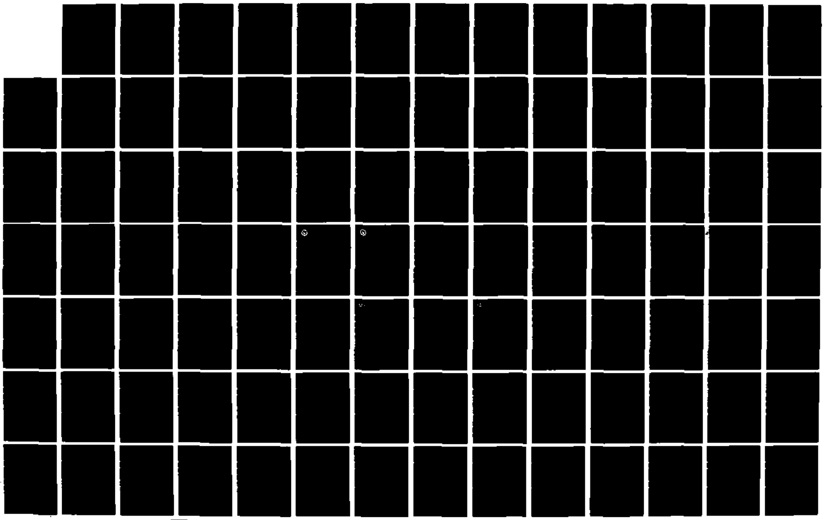

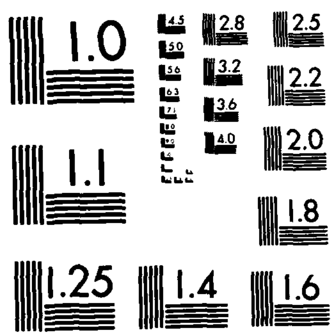
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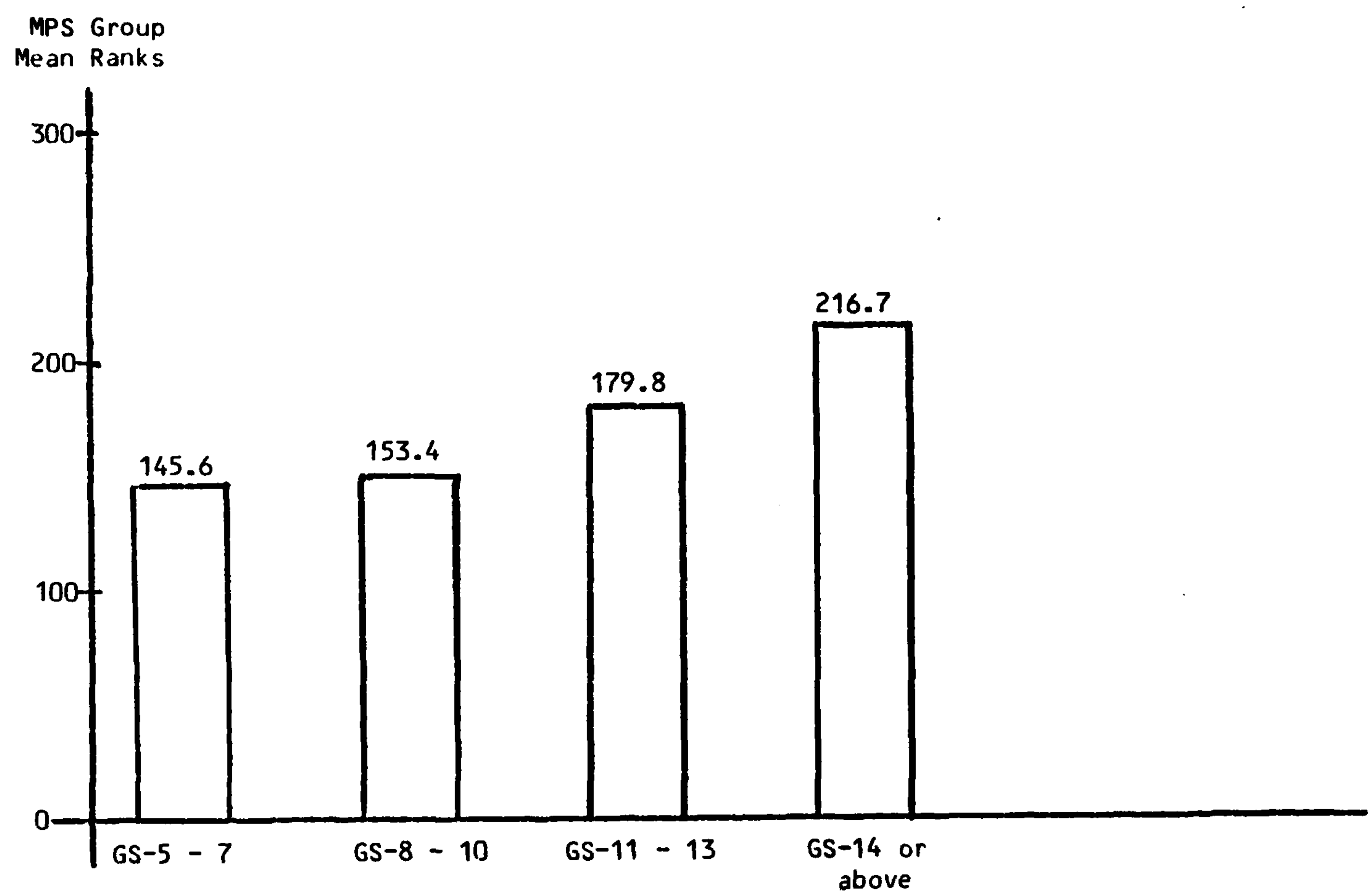

Figure 4-13. MPS Group Mean Ranks by Grade

did not detect any statistically significant differences between the four grade categories. Dunn's test further verified this result. The computer and manual outputs of these tests are shown in Appendix I, along with their data analyses.

Although statistical differences were not found, the chart on Figure 4-13 indicates that as grade increased, so did the MPS group mean rank. This showed that, although not statistically significant, a trend existed as an engineer progressed upward in grade. Specifically, BCE civilian engineering jobs which were low in the GS grade level were also low in the organizational hierarchy. Therefore, lower-graded BCE civilian engineering jobs had less potential to internally motivate the incumbent than did higher-graded positions. Conversely, the higher-echelon civilian engineering positions carry a higher GS grade level. These higher-graded positions had a greater potential to motivate the jobholder.

Thus, it was determined that statistically, no significant differences existed among the four grade categories. This portion of Research Hypothesis Seven was, therefore, supported. However, it was also found that a nonstatistical trend existed of increased MPS mean rankings with increased GS grade level.

<u>GNS by grade</u>. The nonparametric group mean ranks by grade are shown in Figure 4-14. As with the

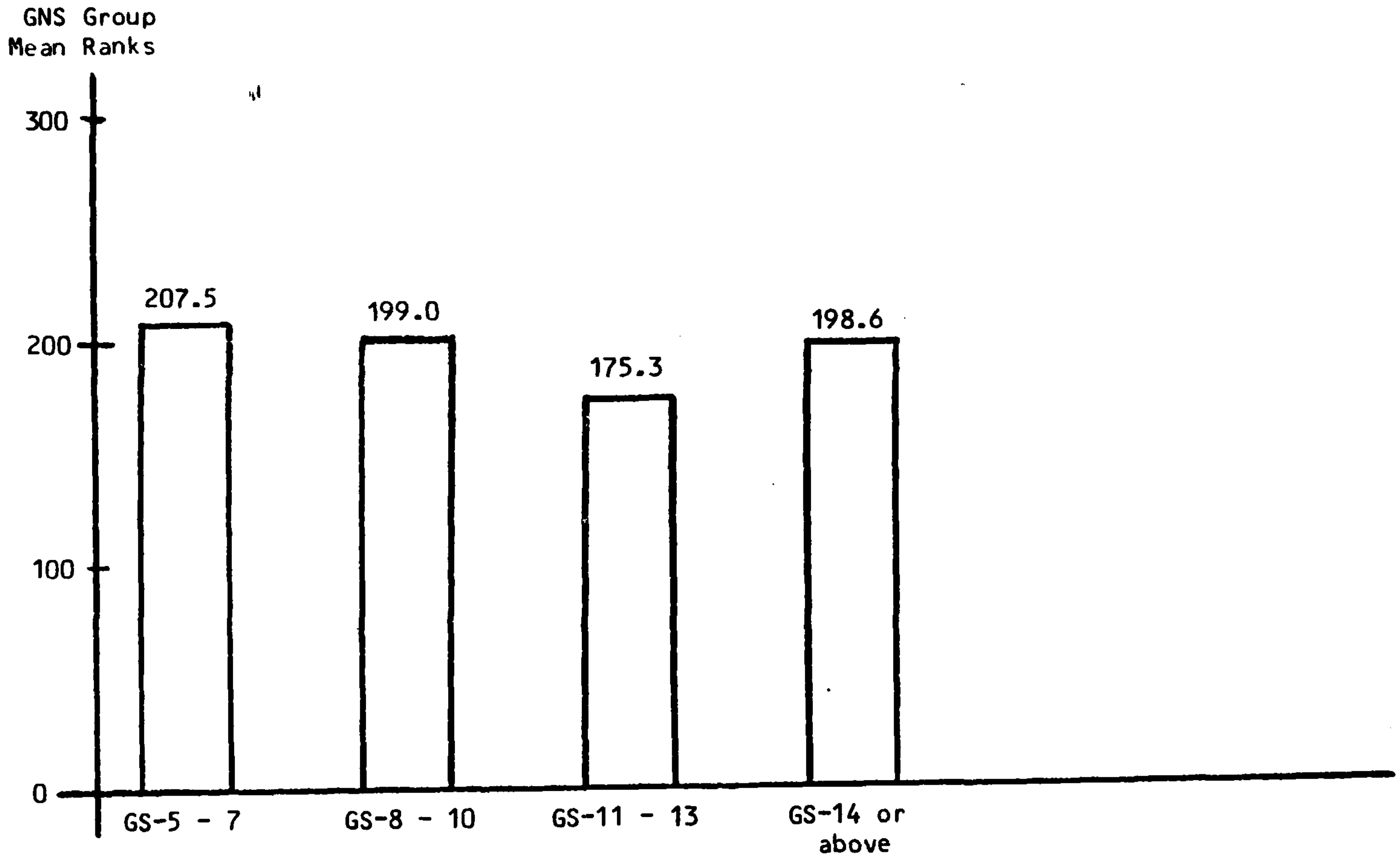

Figure 4-14. GNS Group Mean Ranks by Grade

"MPS-Grade" combination, the several grades' GNS probability distributions were found to not differ significantly. This was shown through use of the Kruskall-Wallis test and Dunn's test. The generated data and subsequent analyses are presented in Appendix I.

Differences in GNS rankings, even from a nonstatistical perspective, were very slight. If a trend did exist, it was the gradual decline of GNS mean rankings from lower-to-higher grade levels, until the highest GS grades were achieved. Above the GS-13 level, the mean GNS ranking increased slightly to that of the GS-8 to GS-10 grade category. This may indicate that with progressive grade achievements, BCE civilian engineers desired less growth satisfaction from their jobs. However, those high-graded engineers who did have this need of growth satisfaction may attain it in jobs above the GS-13 level.

In summary, support for this portion of Research Hypothesis Seven was found. No statistical differences were found between the four grade categories of BCE civilian engineers. This was so regardless of that grade's MPS values.

<u>Summary: research objective six</u>. When all MPS and GNS rankings were collectively observed for both the Age and Grade independent variables, a pattern was detected. As BCE civilian engineers progressed upward through the hierarchy (and simultaneously grow older), their attainment

of, and desire for, internal job motivation changed. Both of these observations were discernible from the data analysis results.

The engineers whose jobs possessed the largest potential to motivate--as measured by MPS rankings--were found to be older (over 45 years old) and at the highest General Schedule grade levels (above GS-13). These civilian engineers have reached the highest attainable BCE positions and are involved in multi-faceted managerial tasks. Correspondingly, since grade level is indicative of pay scale, these engineers receive the highest wages in their organizations. These circumstances produced civilian engineers who indicated relatively high MPS measurements.

The BCE civilian engieners who least desired obtaining growth satisfaction from their jobs were the oldest group (above 56 years old) in the second-highest grade category (GS-11 through -13). These engineers were those approaching retirement who have not achieved the highest GS grade levels in the organization. They are relatively well paid, older, and are beginning to transition from purely technical tasks to more managerial responsibilities. These engineers did not seem to desire to be highly challenged by their work.

The group with the lowest MPS measurements represented those whose jobs did not possess much potential to internally motivate the engineer. Civilian engineers in

the lower two grade categories (below GS-11) in the 26-35 year old group occupied the low-MPS positions. These engineers appeared to be encountering a "mid-career crisis" and did not feel motivated by their jobs. By the same token, this group also reported the highest desire for job motivation. Apparently, their jobs cannot meet their desire for internal challenge.

Based upon these findings, then, job enrichment techniques are most feasible for the younger civilian engineers with a relatively low grade level. Not only are these techniques feasible for this group, but the potential reception by these young, low GS level civilian engieners is positive.

Research objective seven.

> *Determine if the core job dimension measures are approximately equal for both categories (i.e., age and grade) of BCE civilian engineers.*

The final two research hypotheses were used to analyze this objective. Each hypothesis examined a separate BCE civilian engineer category. Significant findings of each hypotheses is presented in the two parts of this section.

Research hypothesis eight. The eighth research hypothesis was used to evaluate the Age categories' core job dimension measures. This hypothesis read:

> The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineers are approximately equal, regardless of age.

None of the five core job dimensions were found to have approximately normal probability distributions (see Appendix E). Because of this, only nonparametric statistical procedures could be applied to the age categories' measurements.

Skill variety. The Kruskall-Wallis H-test produced the group mean rankings shown in Figure 4-15. This test detected that a significant statistical difference existed between the treatments' probability functions. Dunn's Multiple Comparisons test identified one such difference. The oldest category of BCE civilian engineers (56 or over) measured significantly higher than those in the 26-35 age group. The data outputs and their data analyses are explained more fully in Appendix J.

The information in Figure 4-15 shows that as the age of civilian engineers increased, their jobs required them to employ a large variety of skills to accomplish their tasks than did the jobs of junior civilian engineers.

BCE civilian engineers typically attain their highest-echelon positions in the organization when they are oldest. This indicated that the top-level civilian engineering jobs, usually requiring more managerial than technical expertise, possessed the most Skill Variety. At the other end of the scale, the jobs scoring lowest in Skill Variety were occupied by the youngest categories of engineers, especially the 26-35 group. This age group was identified previously as

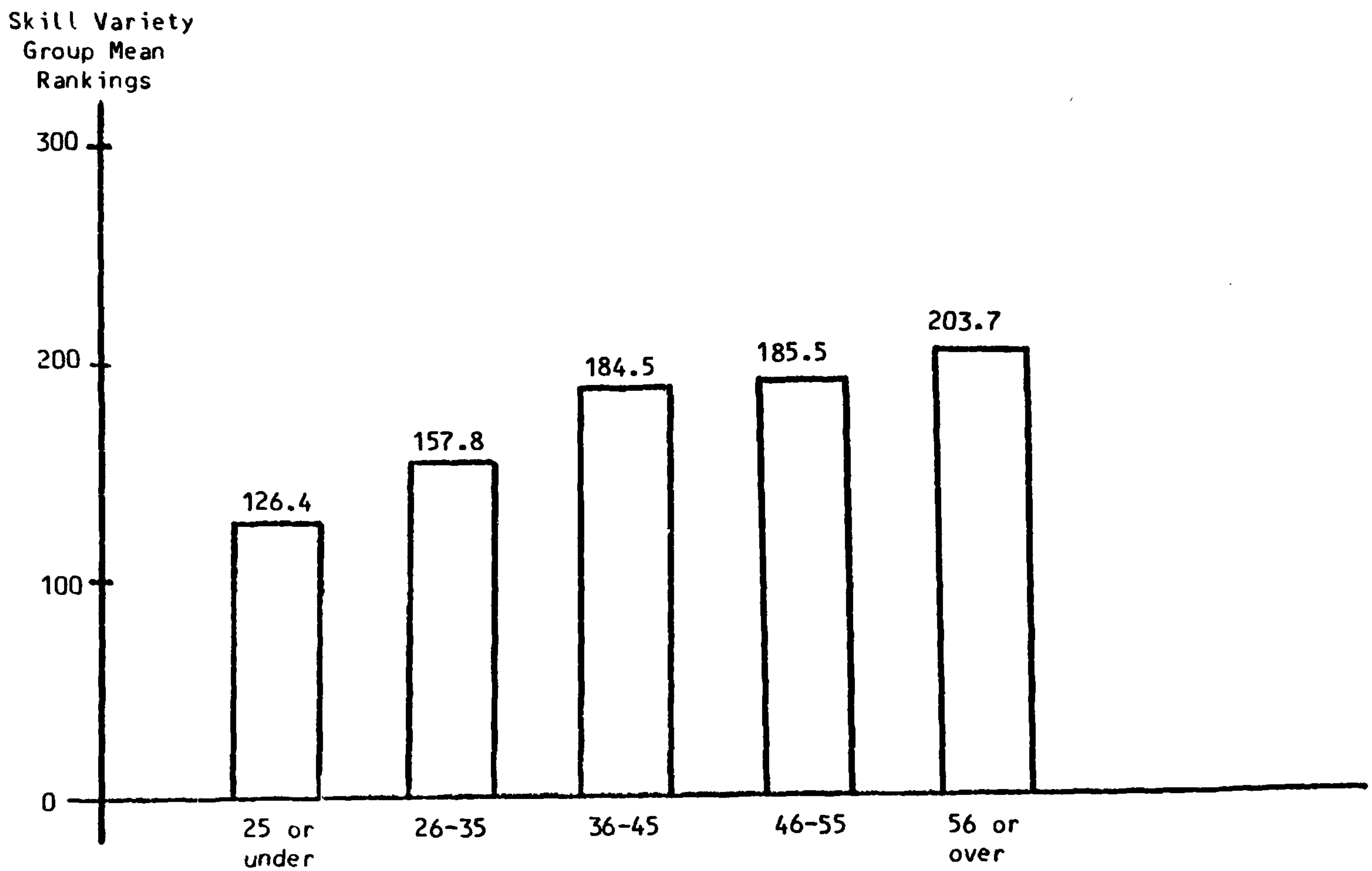

Figure 4-15. Skill Variety Group Mean Rankings by Age

possibly experiencing a "mid-career crisis." Engineers in this age category may be at a decision point to remain with the Air Force or depart it in favor of private employment. Typically, these civilian engineers measuring low in Skill Variety occupied positions lower in the organizational hierarchy involving more technically-oriented problems.

Data analysis, therefore, showed that not all age groups of BCE civilian engineers perceived the same amount of Skill Variety from their jobs. Generally, the youngest two categories of civilian engineers would most benefit from job enrichment applications which promoted Skill Variety.

Task identity. Group mean rankings for the Task Identity Kruskall-Wallis test are depicted in Figure 4-16. This test indicated no significant differences were noted between the five probability distributions. These findings were further verified by Dunn's test. Computer and manual outputs are described in Appendix J, along with their data analyses.

Even from a nonstatistical viewpoint, the group mean ranks of Figure 4-16 show very little difference. No trends seemed to exist in the Task Identity measurements of the five age groups. These results indicated support for this portion of Research Hypothesis Eight. Since all age groups reported approximately equal scores, job enrichment efforts intending to improve a job's Task Identity measure would benefit all groups the same.

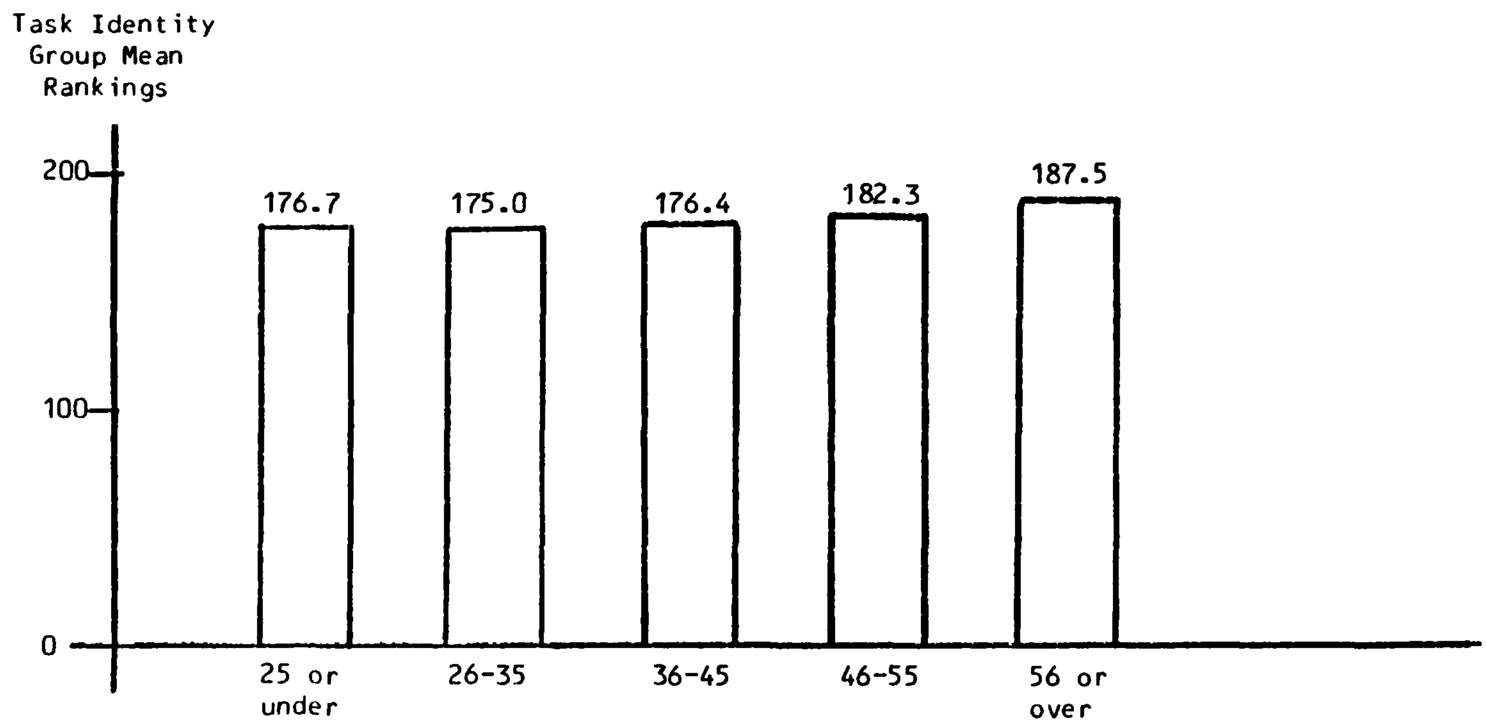

Figure 4-16. Task Identity Group Mean Rankings by Age

Task significance. Group mean ranks for the five age categories, as determined by the Kruskall-Wallis test, are given in Figure 4-17. Results of this test indicated that at least two Task Significance probability distributions significantly differed. Dunn's test identified two of these differences. The eldest two age groups' measures were found to be statistically greater than that of the 26-35 age category. All relevant output and data analysis of these two tests are detailed in Appendix J.

The chart of Figure 4-17 shows a steady increase in the degree to which a job is perceived as substantially impacting the lives or work of others (as measured by the Task Significance mean ranks). The two youngest groups measured lowest in this rating, especially the 26-35 category (the potential "mid-career crisis" group). These two age groups typically occupy the lower-echelon positions in the BCE civilian engineer hierarchy, performing more technically-oriented tasks. The two groups ranking highest in this measure were the 46-55 and 56 or older categories, especially when compared to the 26-35 group. These civilian engineers generally fill the higher-echelon positions in the organization in jobs requiring more managerial than technical expertise.

Data analysis, therefore, revealed that not all five age groups measured equally in Task Significance. The oldest engineers felt their jobs substantially impacted others more

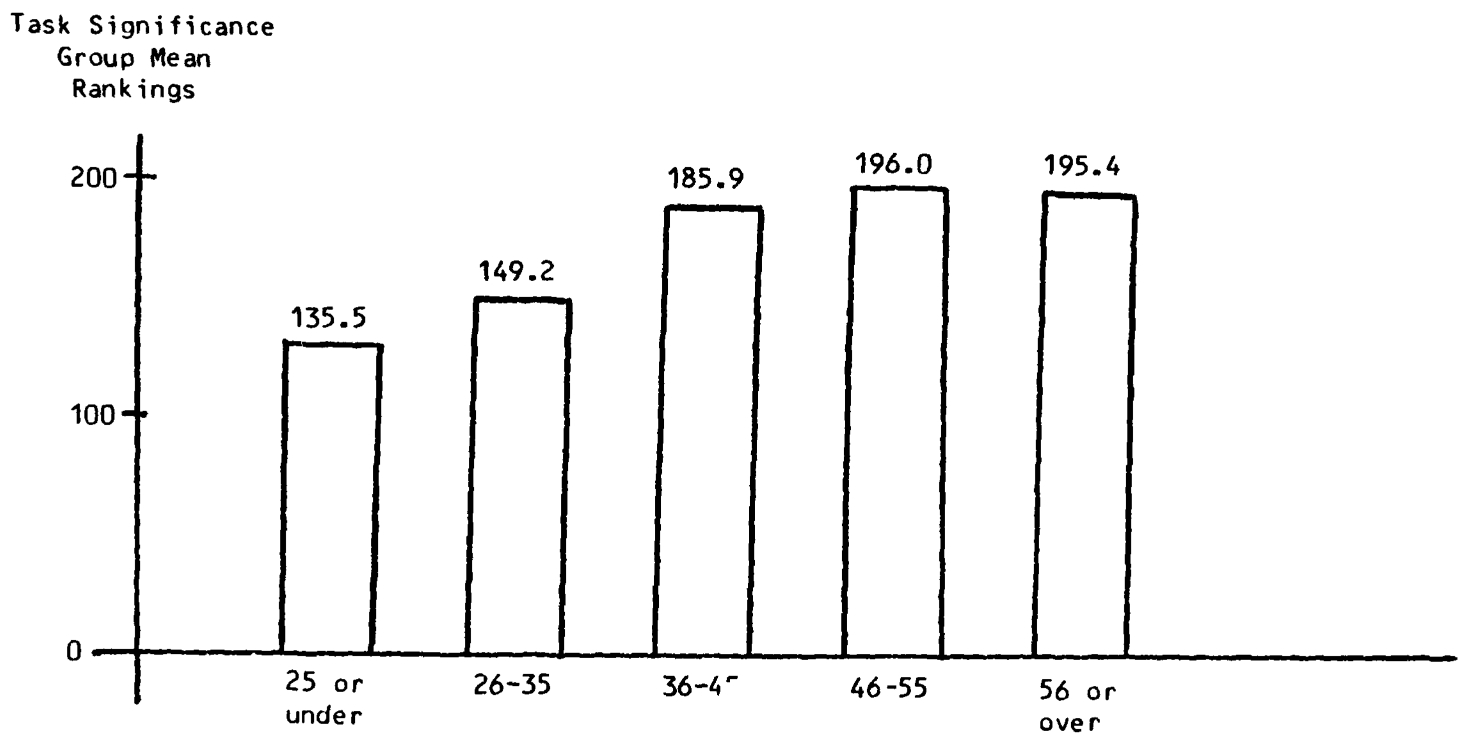

Figure 4-17. Task Significance Group Mean Ranks by Age

than did those of the youngest engineers. Job enrichment techniques which promote Task Significance would therefore be more beneficial to the younger civilian engineer.

Autonomy. Figure 4-18 shows the mean ranks by age from the Kruskall-Wallis test. The K-W test failed to indicate significant differences between the five age groups. This finding was supported by Dunn's Multiple Comparisons test. Data output and analysis are described in Appendix J.

The numeric values of the group mean rankings revealed that Autonomy scores declined somewhat from the youngest (25 or under) to next-older age category (26-35). These measurements then gradually increased with increasing age. Although not statistically significant, the same trend as detected with other core job dimensions was observed. The younger BCE civilian engineers, occupying technically-oriented positions at the lower end of the organization's hierarchy, were allowed lesser amounts of freedom in scheduling their tasks and in determining work procedures. The 26-35 age group, the potential "mid-career crisis" engineers, especially perceived their jobs as lacking in this measure. However, the oldest BCE civilian engineers, at the higher, managerial end of the hierarchy, did perceive their jobs as permitting substantial amounts of Autonomy.

Statistically, though, all five categories of BCE civilian engineers reported approximately equal degrees of

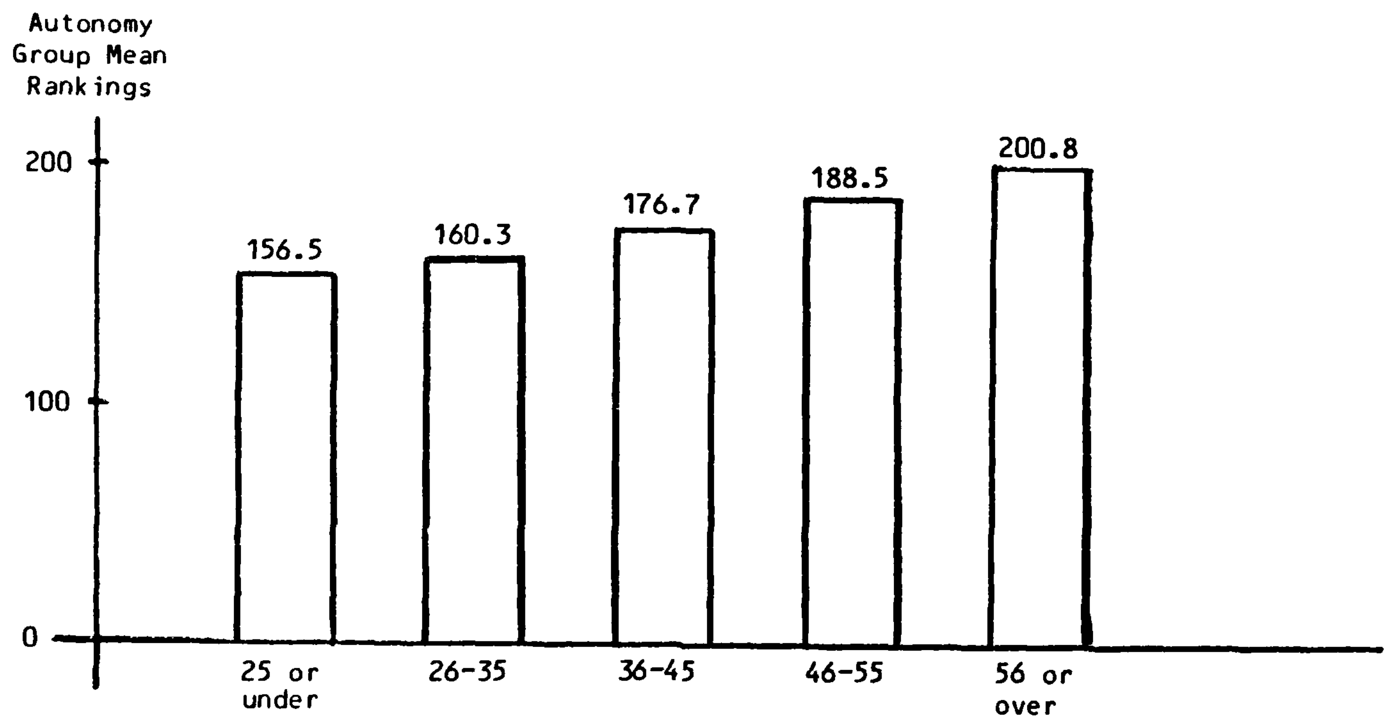

Figure 4-18. Autonomy Group Mean Ranks by Age

Autonomy in their jobs. Job enrichment techniques would not appear to be able to cause greater improvement in any one age group's Autonomy rankings.

Job feedback. The Kruskall-Wallis H-test produced the group mean ranks listed in Figure 4-19. This test revealed the existence of at least one significant difference between the five probability distributions. Dunn's test indicated that these differences lay, as with the other dimensions, between the two oldest age groups and the 26-35 age category. The computer and manual outputs are given in Appendix J along with their data analyses.

Comparing the numerical values of group mean ranks in Figure 4-19, the identical trend of increasing measurement with increasing age--following a low point in the 26-35 group--was detected. The youngest two engineer groups reported lower degrees of Job Feedback than did their older counterparts. This was markedly so for the "mid-career crisis" age category.

Job Feedback measures, therefore, were found to differ significantly between three of the five age groups. Job enrichment techniques which improve this measure are needed most by the younger engineers, particularly those encountering a career decision point.

Research hypothesis nine. The final hypothesis of this research was used to analyze the Grade categories' core job dimension measures. Research Hypothesis Nine read:

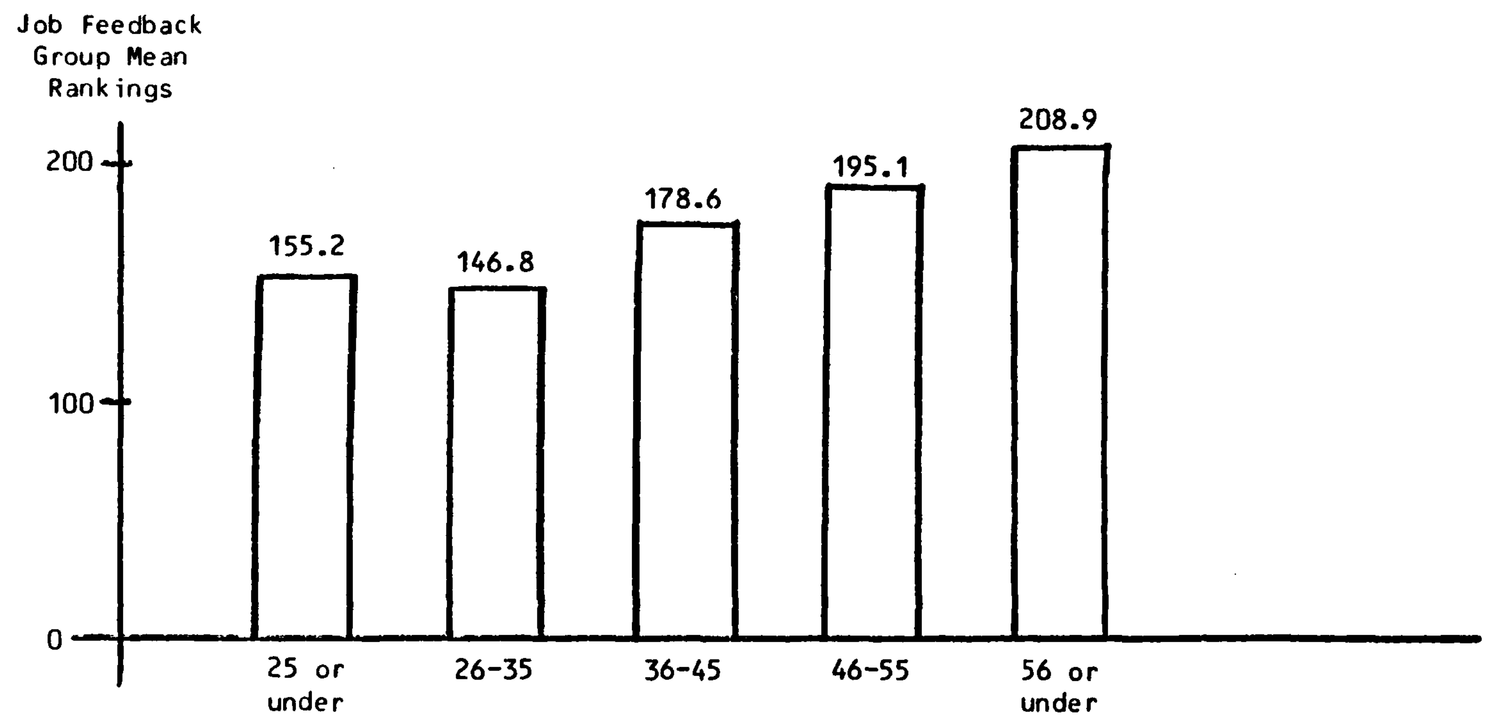

Figure 4-19. Job Feedback Group Mean Ranks by Age

> The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineers are approximately equal, regardless of grade.

Only nonparametric statistical tests could be run upon these dependent variables because the measures were not normally distributed. Each of the five variables were analyzed separately and are so presented in this section.

Skill variety. The group mean rankings of the four Grade categories determined by the Kruskall-Wallis procedure are shown in Figure 4-20. The K-W test detected the existence of at least one significant difference between the grades' probability distributions. Dunn's Multiple Comparisons test identified these differences as laying between the highest grade category (GS-14 or above) and both of the two middle grade groups (GS-8 to -10 and GS-11 to -13).

Examining Figure 4-20 shows that Skill Variety mean rankings numerically decline from the first- to the second-lowest grade categories. Beyond the second-lowest grouping, however, the Skill Variety rankings rose steadily until the mean ranks peaked with the senior grade category. This measurement denotes how much the job requires incumbents to use a variety of their skills and talents. The two middle categories did not perceive their jobs as demanding this variety as much as the lowest- and highest-grade groups.

Typically, an engineer enters the General Schedule grade system at a low level (usually GS-7 to GS-9) and

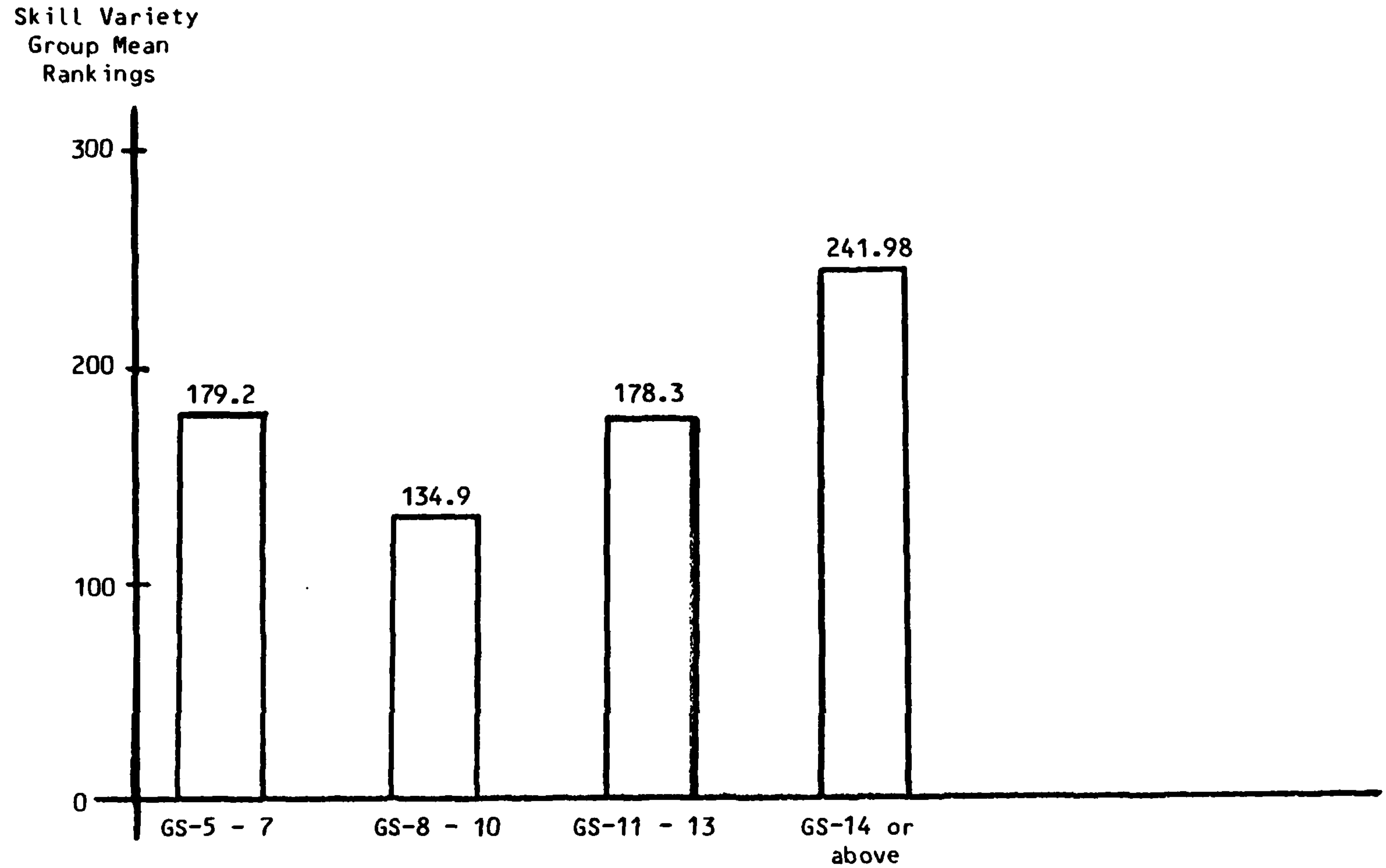

Figure 4-20. Skill Variety Group Mean Ranks by Grade

progresses in grade with increasing tenure. Upon gaining employment as civilian employees, lower-graded engineers felt their technically-oriented jobs contain quite a bit of Skill Variety (relative to their peers, possibly). However, as their tenure increased with age, these engineers, at higher grades, detected less Skill Variety in their jobs. Lower perceived Skill Variety may reflect repetition of the same tasks in the same job rather than an actual decrease in the job's demand for Skill Variety. Concurrent with this decrease in measure, these civilian engineers begin to enter the "mid-career crisis" stage identified earlier in this chapter. After resolving this "crisis" by remaining with the Air Force, their measures of Skill Variety increased with tenure (and as a result, with increasing grade). This fact may be due in large part to entry into positions with added managerial responsibilities. For those civilian engineers advancing above the GS-13 grade level, a significant increase in Skill Variety was noted. Positions which rated these high measurements were typically at the head of large BCE organizations. These high level jobs demand still more managerial responsibility of the engineer and subsequently more Skill Variety.

The notion of approximate equality in Skill Variety measures was therefore rejected. Two significant differences were detected, revealing the adverse effect of the "mid-career crisis" upon a civilian engineer's perceived Skill

Variety. Job enrichment applications which improve a mid-level civilian engineer's Skill Variety would prove to be beneficial for BCE civilian engineers.

Task identity. The K-W test produced the group mean ranks shown in Figure 4-21. The Kruskall-Wallis procedure did not detect any statistically significant differences in the four probability distributions. Dunn's test further confirmed this finding. Data output and their analyses are given in Appendix J.

The graph of group mean ranks shows that, nonstatistically, the jobs of the lower three BCE civilian engineer grades required them to work from start to finish on projects which had clearly identifiable outcomes. These grades of engineers are those which typically hold more technically-oriented jobs, although the GS-11 to GS-13 category does begin to transition into managerial-type positions. These groups of engineers, therefore, were better able to contribute to a project throughout its life cycle. The highest grade category, GS-14 or above, measured the lowest in Task Identity. These engineers possess jobs almost exclusively in managerial functions. Because of this, their ability to work from beginning to end on any project was very limited.

Nevertheless, the four grades did not vary statistically in their rankings. The null hypothesis of approximate equality was therefore upheld for this variable. Job

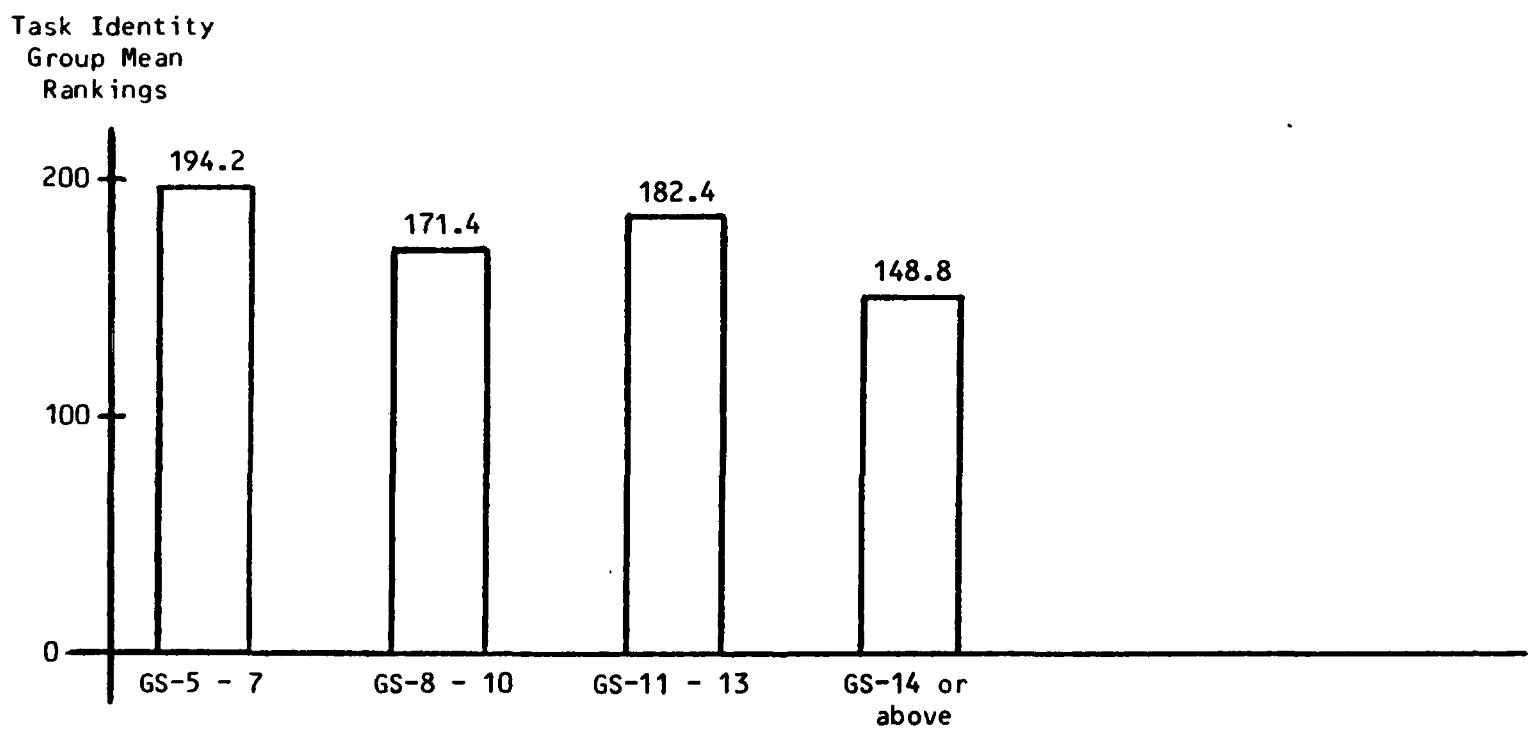

Figure 4-21. Task Identity Group Mean Ranks by Grade

enrichment efforts to improve civilian engineers' Task Identity perceptions were not found to be more needed by any one category.

Task significance. The mean ranks generated by the Kruskall-Wallis test for the Task Significance variable are shown in Figure 4-22. This test detected that at least one significant difference existed between treatment probability distributions. Dunn's test identified one such difference. The senior grade category, GS-14 or above, ranked significantly higher than the GS-8 to GS-10 group. Output data and their analyses are described in Appendix J.

The above result and a nonstatistical comparison of the group mean ranks signified the same trend noted in the Skill Variety variable analysis. The youngest, lowest-graded BCE civilian engineers indicated that their jobs substantially impacted the lives and work of other people. These jobs are almost exclusively technical in nature. As the engineers aged and progressed in grade to the next category (GS-8 to -10), their perceived Task Significance declined considerably. This group of engineers still devotes the majority of their working day to technical problems. At the same time in the engineers' tenure, they encounter the "mid-career crisis" described earlier. Having decided to remain with the Air Force, the civilian engineers progress to the GS-11 to GS-13 category, and begin to transition from technical to managerial positions. With this transition

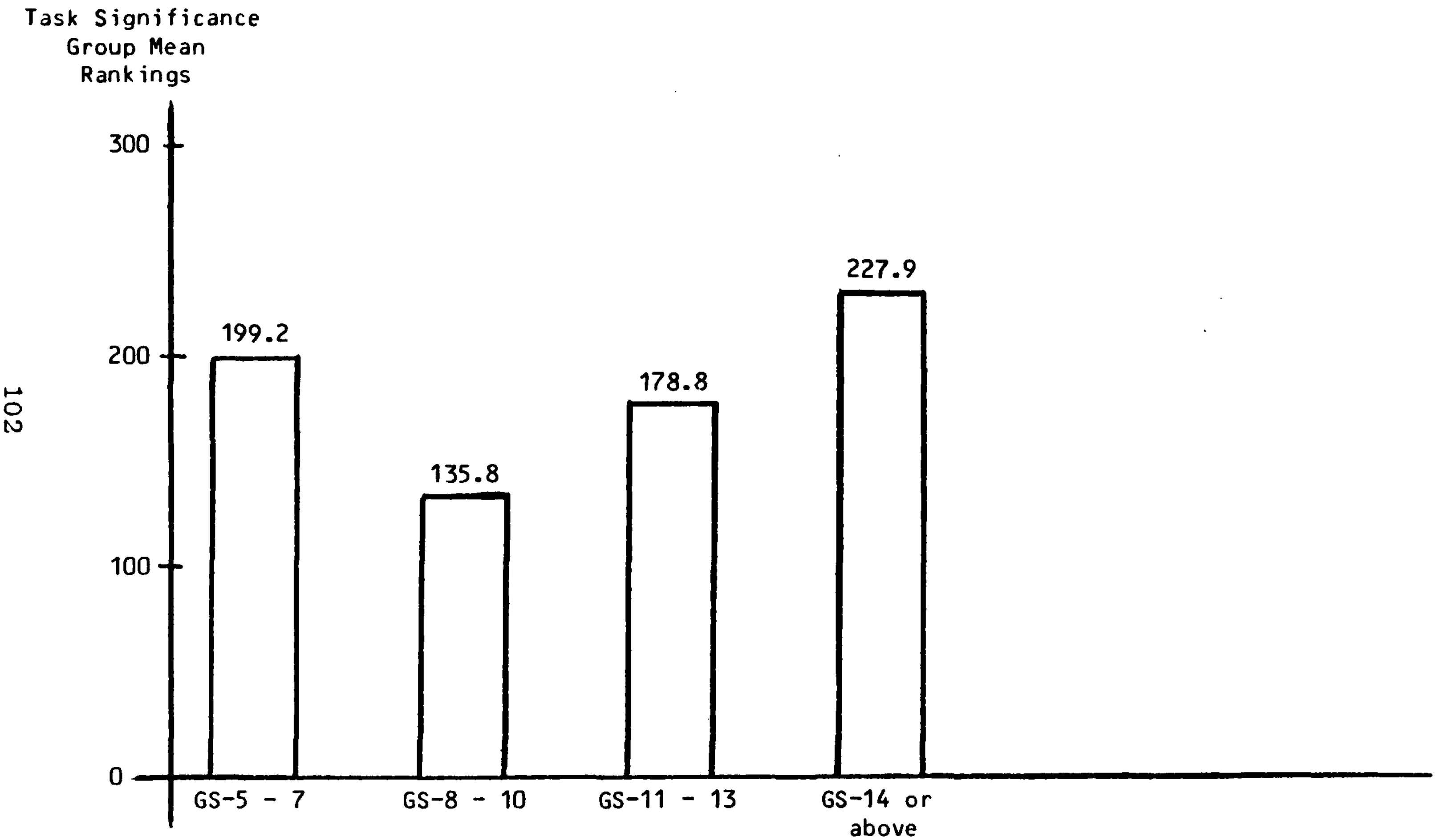

Figure 4-22. Task Significance Group Mean Ranks by Grade

came an increase in perceived Task Significance. As engineers progressed into the highest category of grade levels, GS-14 or above, their measured Task Significance peaked, at a level significantly greater than that of the "mid-career crisis" group.

The notion of approximate equality in the Task Significance measure was not supported. Job enrichment techniques which affect this measure are most needed by the GS-8 to GS-10 category.

Autonomy. The four categories' mean ranks for the Autonomy variable are displayed in Figure 4-23. The K-W test, which produced the mean ranks, detected that significant differences lay in the probability distributions of the four groups. Dunn's test found that the senior grade category, GS-14 or above, measured significantly higher than each of the lower three grade level groups. The generated data and their analyses are given in Appendix J.

The data in Figure 4-23 shows that the Autonomy mean ranks increased with increasing grade category. This indicated that BCE civilian engineers' ability to schedule their own work and to determine work procedures was lowest for the least-grade engineers. These employees fill the most technical positions in the organization. The ability to do their own work scheduling and develop job procedures improved as the engineers rose through grade levels. Autonomy was greatest for the senior-graded civilian engineers. Thus, as

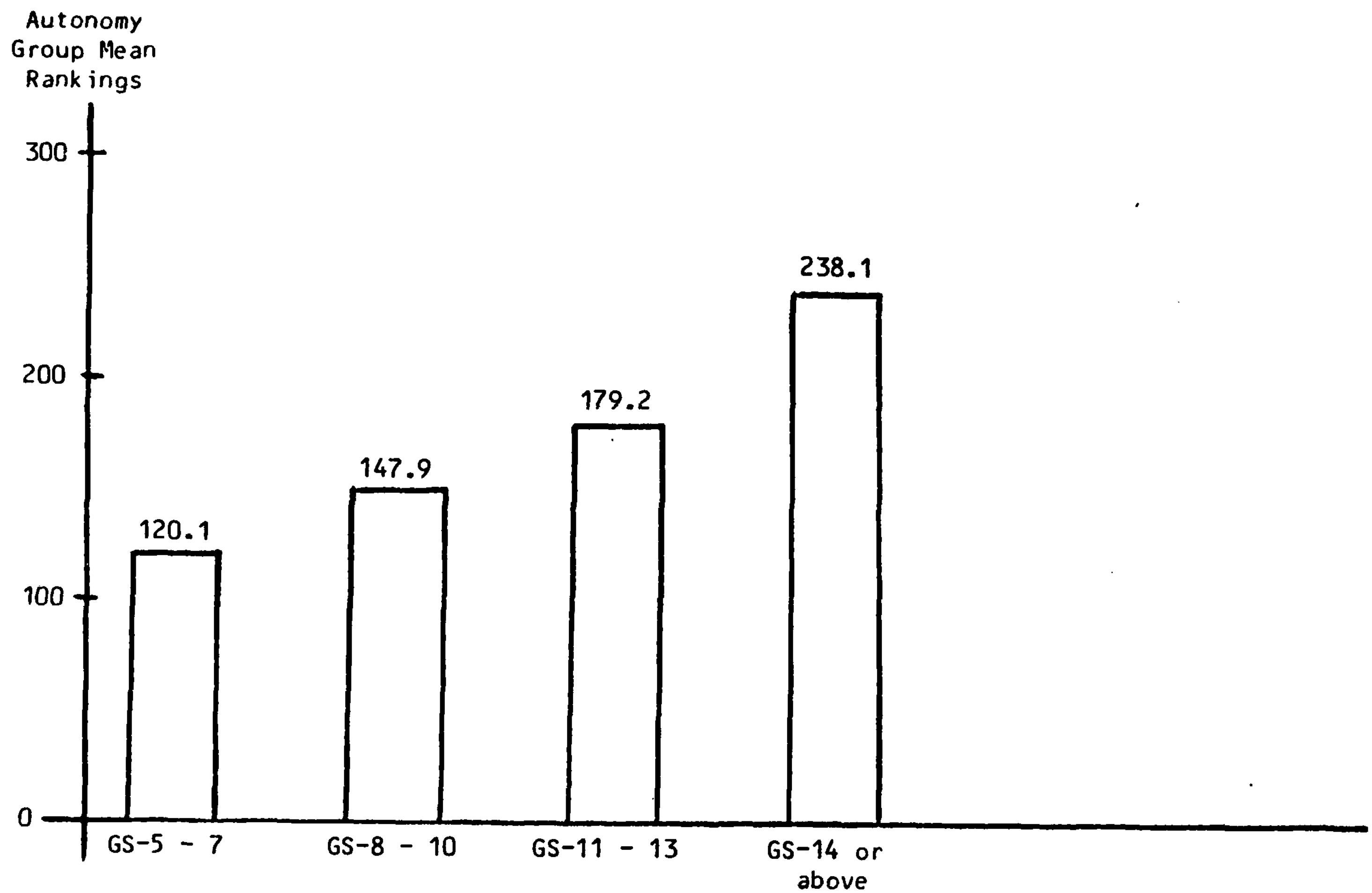

Figure 4-23. Autonomy Group Mean Ranks by Grade

the engineers progressed through the grade levels and transitioned from technically- to managerially-oriented positions, their perceived Autonomy increased significantly.

The four grade categories did not report approximately equal Autonomy measures. Job enrichment efforts which offer increased feelings of Autonomy are therefore most needed by the junior-grade level BCE civilian engineers.

Job feedback. The last dependent variable examined by Grade category, Job Feedback, produced the group mean ranks detailed in Figure 4-24. These ranks were determined by the Kruskall-Wallis procedure. The K-W test also found that no significant statistical differences existed between the four groups' probability distributions. This finding was supported by Dunn's Multiple Comparisons test. Generated data and their analyses are given in Appendix J.

Although no statistical differences were detected, examination of the information in Figure 4-24 revealed the same trend in measurements as with the Autonomy variable. Specifically, as the level of grade category increased, so did the perceived Job Feedback. This measure indicated the degree that performing their work activities provided concrete information of their job performance. From Figure 4-20 then, the lowest-graded, more technically-oriented category perceived the least Job Feedback while the senior-graded, managerial category received the most, with a steady increase in ranking between the two groups. As with previous variable

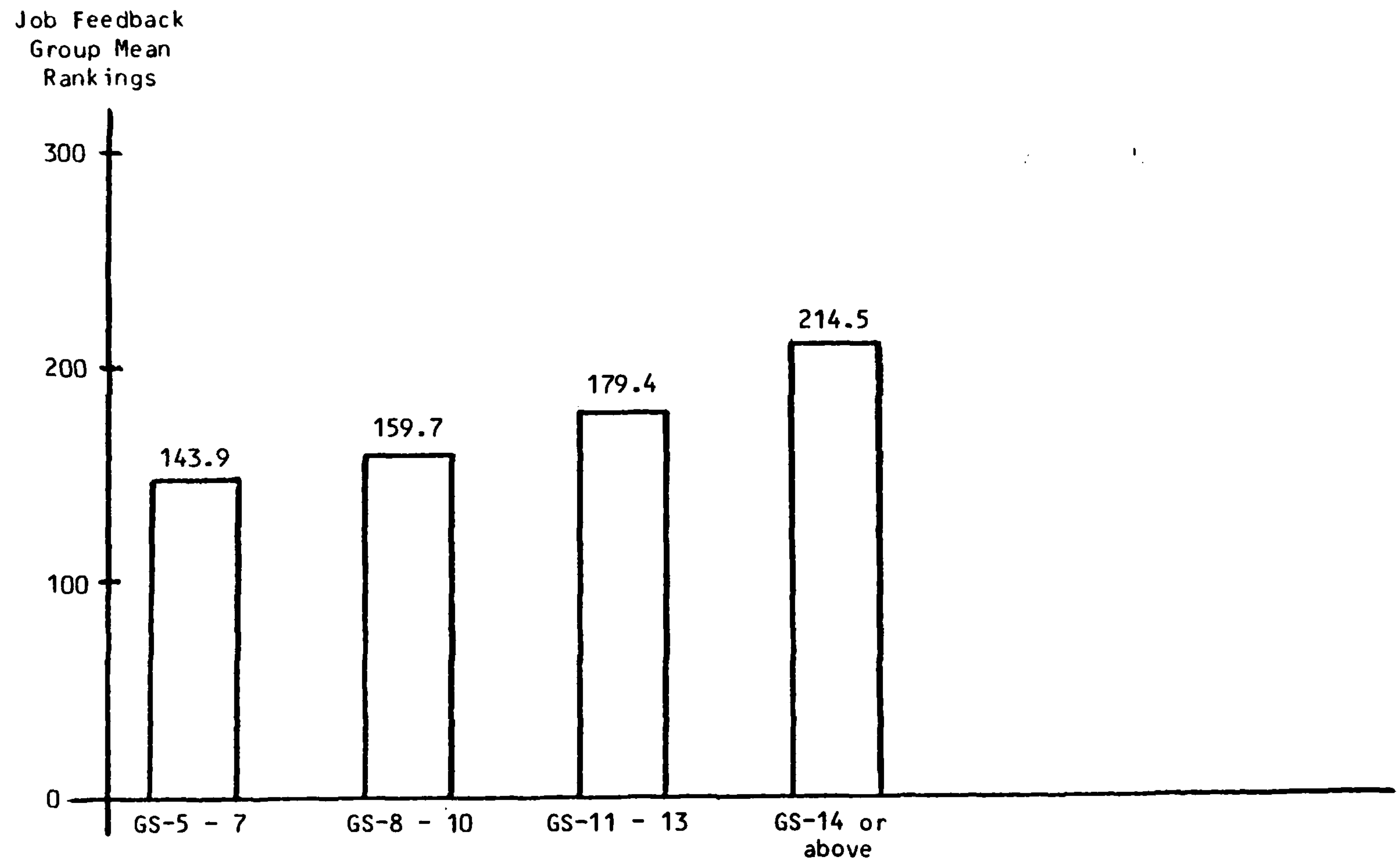

Figure 4-24. Job Feedback Group Mean Rankings by Grade

analysis, the transition from technical to managerial job responsibilities was found to improve perceived Job Feedback.

The null hypothesis of approximate equality, however, was not statistically rejected. The Job Feedback measures were not found to differ significantly. Despite this, job enrichment efforts to improve perceived Job Feedback are needed more for BCE civilian engineers at the lower grade levels.

Summary: research objective seven. When the results of all the ten tests of this research objective were accumulated and analyzed together, three distinguishable patterns emerged. First, data analysis revealed that in all but one instance, the older, higher grade level BCE civilian engineers perceived their jobs as fulfilling the core job dimensions. These engineers typically hold jobs which possess more managerial than technical responsibilities. On the other hand, the younger, lower grade level civilian engineers reported that their jobs did not fully provide these core job dimensions. These engineers are those whose jobs are normally very technically-oriented, requiring little managerial expertise. This was particularly evident among those engineers who may be encountering a "mid-career crisis" of deciding to remain with the Air Force or seek employment in private industry.

Another trend was detected from data analysis on this research objective. It was noted that generally, the job's

ability to provide the core job dimensions to the incumbent improved as the engineers' age and grade level increased. This was always the case beyond the "mid-career crisis" point. Thus, progression through the BCE civilian engineering hierarchy over time provided more positive core job dimension rankings.

The third pattern noted was between technical/managerial responsibilities versus higher-reported measurements. As the engineers progressed from purely technical to purely managerial job requirements, their corresponding core job dimension rankings rose. This seemed to indicate that those positions which are primarily managerial in scope can provide more of the desired work facets than can primarily technical ones.

Job enrichment, then, was seen as having a positive receptor in the younger, lower grade, technically-oriented BCE civilian engineers. The benefits gained from these applications would appear to be greater for these engineers than for any other group.

Other Findings

Four additional batteries of within-group comparisons were conducted by the researcher. These four series were not part of the research objective evaluation, but were conducted as a matter of personal interest. Testing procedures for these tests were identical to those conducted upon other

groups in this research. The results of these tests are presented below; however, their supporting data output and analyses are omitted.

Measurements derived from the JDS were first compared against the respondents' expressed Career Intent. Three replies were presented for the respondent to choose when asked "Judging by your feelings today, do you plan to remain with the Air Force until retirement?" Possible replies were "Yes," "No," or "Undecided." Those who responded "Yes" were found to have jobs which highly motivated them (as measured by MPS scores), significantly more than did those who replied either "No" or "Undecided." Respondents who were "Undecided," however, had the greatest need for challenge from their jobs, although not significantly so. Further, the "Undecided" group generally scored significantly lower than those who expressed a positive career intent in all but one core job dimension. Therefore, application of job enrichment techniques could improve the measurements of those BCE civilian engineers who are unsure of their career intentions, and thereby possibly persuade them to remain with the Air Force.

Job Characteristics Model construct measurements were also contrasted with the Employment Status of Respondent's Spouses. Three responses were available to married respondents: their spouse worked either full- or part-time, or was unemployed. Although no significant differences were

detected, some nonstatistical findings were revealed. The job's ability to internally motivate the civilian engineers was greatest for those whose spouses were not employed, and least for engineers whose spouses worked full-time. Further, the engineers with working spouses (either full- or part-time) scored the lowest in each of the five core job dimensions. The desire for job challenge, however, was greatest among the engineers whose spouses worked full-time. Therefore, job enrichment applications would most benefit engineers of a two-income family.

A third series of within-group comparisons was made with the respondents' Marital Status. Only two responses were possible in the survey: "Married" or "Unmarried." The MPS values of married civilian engineers was comparatively higher than that of their unmarried counterparts, indicating that their jobs provided greater internal motivation to them. The married group also scored higher in GNS values. This showed that they had a greater desire for challenge from their jobs. Despite this apparent match-up of need versus desire for job challenge, in three of the five core job dimensions (Task Identity, Task Significance, and Job Feedback) the married engineers measured lower than the unmarried group. Therefore, room for improvement existed in both categories. Job enrichment applications would seem to be a beneficial technique to enhance both groups of BCE civilian engineers.

The fourth comparison group, based on respondent's Tenure, again showed the gap between desire for, and receipt of, job challenge. The lowest-tenured group (less than six months on the job) perceived their jobs as not providing sufficient internal motivation. While this group's MPS values were comparatively lower than senior-tenured engineers, their GNS scores were the highest of all six groups. This reflected their strong desire for challenge from their jobs. The inability of the low-tenured civilian engineers' jobs to motivate them was further revealed in the core job dimension measurements. In all five variables, the least-tenured group measured the lowest. This finding somewhat paralleled the results from the Age/Grade comparisons. Job enrichment application would apparently find a receptive audience amongst BCE civilian engineers with low tenure.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Summary of Research Effort

Internal sources have indicated that retention of civilian engineers in Air Force Base Civil Engineering organizations was declining. One possible solution to reduce this problem was identified as implementing job enrichment techniques upon these civilian engineers. However, a review of the literature showed that blindly applying job enrichment to any group in any organization may have little effect or even negative effects upon the receptor group. Hackman and Oldham devised a model which cited the individual needs of the potential job enrichment recipient as being a primary moderator in the success of these techniques. Their model, called the Job Characteristics Model, employed a survey instrument called the Job Diagnostic Survey to sample the feasibility of, and potential reception to, job enrichment applications in a given environment.

In an effort to sample the BCE civilian engineer population on their need for, and potential reception to, job enrichment techniques, a JDS instrument was mailed to 482 BCE civilian engineers working in the contiguous United States. Of this number, 358 usable responses were collected for data analysis. The number of usable returned surveys

allowed for less than the hoped-for 95 percent confidence interval; instead, a 90 percent degree of confidence was used in research findings, employing 358 surveys.

Data analysis of these replies was stratified into three distinct parts. The first part used the mean variable scores of the collective BCE civilian engineer group. These variables, taken from the Job Characteristics Model were Motivating Potential Score, Growth Need Strength, Skill Variety, Task Identity, Task Significance, Autonomy, and Job Feedback. The seven variable measurements were compared nonstatistically against several other groups' scores previously measured by other researchers. These other groups were assumed to be sufficiently similar in composition to afford meaningful comparisons. The second part of data analysis evaluated the BCE civilian engineers by Positions. Nine possible job titles were available in the survey response. The same variables as in the first part of data analysis were contrasted, but in this part either parametric or nonparametric statistical comparisons were made. The third part of data analysis compared BCE civilian engineers by Age and General Schedule Grade level. Again, either parametric or nonparametric statistical procedures were employed in these group measurement comparisons.

Conclusions

Base Civil Engineering civilian engineers, as a collective group, measured relatively high in all seven Job

Characteristics Model variables. The internal motivation provided by the jobs, as measured by their collective motivating potential score, was in the upper range of comparative measures. Thus, the feasibility of applying job enrichment techniques to the <u>overall group</u> was not demonstrated. However, the internal need for job challenge by the entire group was also shown to be relatively high. This fact showed that potential reception to the application of job enrichment techniques was positive. Therefore, although not necessarily needed by the BCE civilian engineers as a whole, job enrichment applications should be positively received by the group and improve their internal work motivation. This, in turn, could increase satisfaction of these engineers. Evaluation of the collective group's specific core job dimension measurements showed that, if job enrichment techniques were applied, they should specifically concentrate on improving the BCE civilian engineers' "Task Identity," "Task Significance," and "Autonomy." Although the collective BCE group still measured at the high end of the scale, their scores in these three dimensions compared the worst against similarly-structured group's scores.

Data Analysis showed that the potential reception to job enrichment applications was approximately the same among all nine BCE civilian engineering positions. The need for such techniques, however, was found to be greater

in those positions of lower grade and lower organizational level. These positions typically require more technical expertise of the engineer than managerial ability. The same finding was revealed when comparing each of the five core job dimension measurements by position. In all cases, the lower-echelon, technically-oriented BCE civilian engineer measured lower than an engineer in an elevated, managerial position. Job enrichment applications, therefore, definitely have a potential audience in BCE organizations. Application of these techniques are needed and would be positively received by the BCE civilian engineers lower in the organizational hierarchy, whose jobs are more technical in scope.

Other comparisons contrasted the BCE civilian engineers' variable measurements by Age and GS Grade level. Analysis showed that the engineer's desire for job challenge was greatest by lower-graded, younger, technically-oriented engineers. However, the ability of their jobs to provide this internal challenge was found to be lowest of all groups. This lower group was also found lacking in their perception of core job dimension fulfillment. They were hypothesized as experiencing a "mid-career cirsis" in deciding to remain with the Air Force or depart in favor of private employment. These civilian engineers measured lowest in internal motivation and specific core job dimensions. Job enrichment applications were found to be needed by the lower-graded, younger, technically-oriented BCE civilian engineers.

Potential reception by this group was shown to be extremely positive.

Four other series of comparisons were made in this research effort, contrasting groups by their Career Intent, Spouse's Employment Status, Marital Status, and Tenure. Analysis revealed that the jobs of BCE civilian engineers who were undecided as to their career intent, low in tenure, and had a working spouse, provided little internal motivation. They also measured lowest in the core job dimensions. These same civilian engineers, however, displayed the greatest desire for work motivation. On the other hand, respondents' Marital Status did not specifically reflect their perception of internal job motivation or desire for it. The married engineers had the greatest need for job challenge and reported that their jobs fulfilled their desires. The married group also scored lower in the core job dimension measurements.

Job enrichment applications, therefore, would prove beneficial to certain groups within BCE organizations. Although not all civilian engineers want or desire job enrichment, a number of them do. This was especially shown in the engineers who may be experiencing a "mid-career crisis." This group is expected to be the most likely to depart the Air Force, serving to prolong the existing retention problem. Job enrichment application could, therefore, serve Air Force Civil Engineering in several ways, most noticeably through

a potential increase in the retention rate of civilian engineers. At the very least, these applications would create a work environment more meaningful and motivating to BCE civilian engineers.

Recommendations

Two recommendations are offered here in light of these findings. Neither recommendation requires the expense of any money in an already tightly-budgeted function as BCE. Both recommendations do, however, demand the expense of time and effort by managers of BCE civilian engineers.

The first recommendation is that job enrichment techniques be applied to BCE engineering positions, at least in test organizations in various parts of the CONUS. Results of the job enrichment effort in these test organizations could be measured by a "pre-test/post-test" experiment. Data from this research could be employed as the pre-test measurements. All that would be needed, then, is a similar experiment as this research conducted in the test organizations at some future time. If determined to be a beneficial technique, job enrichment efforts could be introduced Air Force-wide. Managers at these test sites should be informed that application should be equitable among all civilian engineers. The focus of these efforts, however, should be directed toward the lower-graded, younger, technically-oriented engineers. These applications should not be a one-time

effort, but rather should receive continued emphasis by managers of these engineers.

Managers of these engineers need some sort of continuing education in the practice of job enrichment application. Education should not consist of simply how to apply job enrichment, but also why these techniques are beneficial and how to identify those who would benefit most from their application. This could be accomplished by adding lectures in courses offered in the AFIT School of Civil Engineering and through articles published in the Air Force Engineering and Services Quarterly.

Suggestion for Future Research

Three theses, including this one, have examined job enrichment applications to various populations within the Base Civil Engineering organization (see also Barton, LSSR 71-81, and Peters/Duke, LSSR 58-82). A future thesis effort could tie these three research projects together to determine the effects of applying one job enrichment effort upon all BCE employees. Alternatively, a future thesis could develop an implementation plan for applying job enrichment techniques to the various groups in BCE organizations.

APPENDIX A

SUPPORT FOR JOB DIAGNOSTIC SURVEY

Reliability of JDS Measures

Several studies have been undertaken since the introduction of the JDS in 1975 to determine the survey's validity and the predictive ability of the Job Characteristics Model. Dunham, Aldag and Brief determined the internal consistencies of the job dimensions for 20 occupational subsamples in a study of 5,945 people. These respondents, drawn from five different organizations, possessed a wide variety of jobs and backgrounds ranging from unskilled workers to top level corporate executives. The internal consistency measured for the "engineer" subsample (n = 168) compared very well against the "combined" sample's internal consistency (r = 0.68 to 0.81 for "engineers" versus 0.68 to 0.71 for "combined"). (8:221) In 1978, Pierce and Dunham administered the JDS to 155 employees in a multiple-line insurance company and compared the internal consistencies of the JDS job dimensions with similar measures in another survey instrument (the Job Characteristics Index developed by Sims, Szilagyi and Keller). Although the Job Characteristics Index (JCI) showed stronger internal consistency than did the JDS (r = 0.90 with JCI versus 0.69 with JDS), the authors attribute this to a possible built-in bias in administering the tests. (30:127-128) Hackman and Oldham in evaluating their model themselves were somewhat more critical but

still cited support for the internal consistency of the job dimensions. In their research, 658 employees working in 62 different jobs in seven organizations were administered the JDS. They found this consistency to range from a high of r = 0.78 to a low of 0.59. (13:164) Research on the JDS, therefore, supports the internal consistencies of the job dimensions, "clearly demonstrating the utility of the Job Diagnostic Survey in job redesign research [33:128]."

Hackman and Oldham, using the same sample as above, also put the Job Characteristics Model's tenets to the test in their 1976 study. Their findings support the correlation between the presence of the critical psychological states and work outcomes, and between the summary MPS value and the work outcomes. The summary MPS score was found to be a better predictor of outcomes than were any of its component job dimensions. (14:262) Support for the model-specified relationship between certain core job dimensions and certain critical psychological states was found, although not as conclusively as expected (14:266). The relationships between core job dimensions and critical psychological states for high versus low GNS employees were in the predicted direction and, except for Task Identity, were statistically significant (14:270-271). Finally, the model-specified MPS formula was compared with four other formulas for combining the job dimensions and correlated with three questionnaire-based dependent measures. The expected MPS formulation was not

disconfirmed by the data, but it was not found to provide the best fit (multiple regression was found to be the best correlate with the motivation and satisfaction work outcomes). (14:273-274)

Support of JDS Findings

In a different experiment, Hackman and Oldham administered the JDS to over 1,000 employees working on about 100 diverse jobs in more than a dozen organizations over a two year period. Their findings support the contention that jobs which score relatively high in the core job dimensions--and therefore have a high MPS--provide the incumbent with greater amounts of motivation and satisfaction. (16:66) Also supported was the notion that employees with relatively high GNS scores respond better to high-MPS jobs than do employees with lower GNS scores. While both high and low GNS employees showed increases in internal work motivation as the job's MPS increases, the rate of increase for high GNS workers was significantly greater, demonstrating the moderating influence of individual needs upon work outcomes. (16:66-67)

Other research shows support for portions of the Job Characteristics Model. Abadie and Laske showed, with mixed support, that individuals in USAF Transportation Squadrons whose jobs have been enriched demonstrate a significant increase in MPS. They did not find an increase in perceived

job satisfaction among workers whose jobs were enriched, but did find support for the moderating effect of individual growth needs on work outcomes. (1:61) Martin, in a sample of 250 full-time employees of a service organization, showed positive correlations between two job dimensions (Skill Variety and Feedback) and the work outcome of job satisfaction (26:319). Blackburn and Johnson, sampling 1,056 male Air Force line officers with less than seven years active duty, showed positive correlations between the core dimension of Autonomy and the work outcome of job satisfaction (5:65-67).

APPENDIX B

JOB DIAGNOSTIC SURVEY PACKAGE

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

REPLY TO ATTN OF: AFIT/LS (1Lt Smiley, AV 785-6569)

SUBJECT: Job Diagnostic Survey Package

TO

1. Attached are surveys developed by researchers at the Air Force Institute of Technology, Yale University, and the University of Illinois. These surveys are part of an AFIT graduate student's master's thesis effort. The surveys measure the respondents' perceptions and attitudes toward their jobs and job environments.

2. Please distribute one survey package to the Deputy Base Civil Engineer, at least two packages to civilian engineers in the Design Section, and at least one package both to civilian engineers in the Environmental Planning and Construction Management Sections. Participation by these respondents is entirely voluntary, and replies will be kept anonymous. Instruct respondents to return their completed surveys within one week after receipt.

3. Headquarters USAF Survey Control Number 82-29 has been assigned to this instrument. All provisions of the 1974 Privacy Act apply toward the use of these survey packages.

4. Finally, please forward the attached letter to the Base Chief of Civilian Personnel. The letter acts to comply with any possible local union bargaining agreements.

Alan R. Stout

ALAN R. STOUT, Lt Col, USAF
Acting Dean
AFIT School of Systems and Logistics

2 Atch
1. ___ JDS Survey Packages
2. Letter to CPO

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

REPLY TO ATTN OF: AFIT/LS (1Lt Smiley, AV 785-6569)

SUBJECT: Survey of Civilian Employees

TO: DPC

1. Enclosed is the Job Diagnostic Survey to be used as part of an AFIT graduate student's thesis effort. The survey is being distributed to several civilian engineers in the Base Civil Engineering squadron. It measures respondents' attitudes and perceptions toward their jobs and job environments.

2. The use of this instrument has been approved by Headquarters USAF for surveying on base (Survey Control Number 82-29). National union consultation has been completed with AFGE, NFFE, and NAGE. This package has been forwarded to you to insure that any statutory and/or local contractual obligations will be honored. Please notify 1Lt Smiley if any conflicts arise.

Alan R. Stout

ALAN R. STOUT, Lt Col, USAF
Acting Dean
AFIT School of Systems and Logistics

Atch
Job Diagnostic Survey

PRIVACY STATEMENT

In accordance with paragraph 30, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority:

(1) 5 U.S.C. 301, Departmental Regulations, and/or

(2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation; and/or

(3) DOD Instruction 1100.13, 17 Apr 68, Surveys of Department of Defense Personnel; and/or

(4) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal Purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on the data provided, will be included in written master's theses and may also be included in published articles, reports or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

Please circle or enter the appropriate response(s) for each of the following questions. Please do not consult any other individuals, texts, or regulations in answering the questions. They are designed to interpret your attitudes only.

NOTE: All questions may not be relevant to you in this section. Please disregard these questions and answer only those that apply to you.

1. What is your current grade?

   a. GS-5 through GS-7 b. GS-8 through GS-10 c. GS-11 through GS-13

   d. GS-14 and above e. Other (specify) __________

2. What is your age?

   a. 25 or younger b. 26-35 c. 36-45 d. 46-55 e. 56 or older

3. How long have you been employed as a civilian engineer by the Department of Defense?

a. 6 months or less b. 7 months-23 months c. 2 years-6 years

d. 7 years-15 years e. 16 years-25 years f. 26 years or longer

4. How long have you been at your present station as a civilian engineer?

a. 6 months or less b. 7 months-23 months c. 2 years-6 years

d. 7 years-15 years e. 16 years-25 years f. 26 years or longer

5. If you were employed as an engineer in private industry prior to your current assignment, how long were you employed?

a. 6 months or less b. 7 months-23 months c. 2 years-6 years

d. 7 years-15 years e. 16 years-25 years f. 26 years or longer

6. If you had prior active military service, how long did you serve?

a. 2 years or less b. 3 years-6 years c. 7 years-19 years

d. 20 years or longer

7. If you had prior active military service, what was the highest rank you achieved?

a. E-1 - E-3 b. E-4 - E-6 c. E-7 - E-9

d. 0-1 - 0-3 e. 0-4 - 0-5 f. 0-6 or higher

8. Which professional registration do you possess?

a. None b. RA c. PE d. EIT e. Other (specify) ________

9. Are you currently married?

a. Yes b. No

10. How many children live at home with you?

a. None b. 2 or less c. 3-5 d. 6 or more

11. What is the age of the youngest child living with you?

a. Not applicable b. 1 year or less c. 2-6 years old

d. 7-14 years old e. 15-18 years old f. 19 years or older

12. Do you own the dwelling you now reside in?

a. Yes b. No

13. If you own your present dwelling, how long have you owned it?

a. 1 year or less b. 2 years--4 years

c. 5 years--19 years d. 20 years or longer

14. Is your spouse employed?

a. Yes, full-time b. Yes, part-time c. No

15. Why did you decide to seek employment with the Air Force as a civilian engineer (circle all applicable responses)?

a. Job security b. Pay and Promotion c. Location of employment

d. Local environment (cultural, educational, religious, economic)

e. Job attractiveness (task variety, interesting work, etc.)

f. Spouse's employment opportunities

g. Retired/resigned from military service at your location

h. Other (specify) ______________________________

16. In your opinion, what factors would deter an engineer from seeking employment with the Air Force as a civilian?

a. Job security b. Pay and Promotion c. Location of employment

d. Local environment (cultural, educational, religious, economic)

e. Job attractiveness (task variety, interesting work, etc.)

f. Spouce's employment opportunities

g. Restrictions of Air Force employment (adherance to regulations, etc.)

h. Other (specify) ______________________________

17. Judging by your feelings <u>today</u>, do you plan to remain with the Air Force until retirement?

a. Yes b. No c. Undecided

18. On a scale of "one" through "seven," how well do you like your present location of employment?

1----------2----------3----------4----------5----------6----------7

Very little; I would prefer to be located somewhere else	Moderately	Very much; I would strongly dislike to located elsewhere

19. What is your engineering degree area specialty?

a. General b. Landscape Architecture c. Architecture

d. Civil e. Mechanical f. Electrical g. Other (specify) ________

20. What is your current position?

a. Deputy Base Civil Engineer b. Chief Engineer c. Chief of Design

d. Design Engineer e. Programmer f. Environmental Engineer

g. Chief of Construction Management h. QAE/Contract Inspector

i. Other (specify) ____________________

21. Which factors would possibly deter you from leaving your current job location to take a promotion at another Air Force Base (circle all applicable)?

a. Home ownership b. Preference of current geographic location

c. Factors other than geographic location of your present location (cultural, educational, religious)

d. Children's present schools e. Relatives/friends in present location

f. Spouse's current employment

g. Other (specify) ____________________

The remainder of this survey is the Job Diagnostic Survey developed by J. Richard Hackman of Yale University and Greg R. Oldham of the University of Illinois.

J O B   D I A G N O S T I C   S U R V E Y:

SHORT FORM

This questionnaire was developed as part of a Yale University study of jobs and how people react to them. The questionnaire helps to determine how jobs can be better designed, by obtaining information about how people react to different kinds of jobs.

On the following pages you will find several different kinds of questions about your job. Specific instructions are given at the start of each section. Please read them carefully. It should take no more than 10 minutes to complete the entire questionnaire. Please move through it quickly.

The questions are designed to obtain your perceptions of your job and your reactions to it.

There are no "trick" questions. Your individual answers will be kept completely confidential. Please answer each item as honestly and frankly as possible.

Thank you for your cooperation.

For more information about this questionnaire and its use, please contact:

Prof. J. Richard Hackman
Department of Administrative Sciences
Yale University
New Haven, Connecticut 06520

OR

Prof. Greg R. Oldham
Department of Business Administration
University of Illinois
Urbana, Illinois 61801

OR

AFIT/LS
Wright-Patterson AFB OH 45433

SECTION ONE

This part of the questionnaire asks you to describe your job as objectively as you can.

Please do not use this part of the questionnaire to show how much you like or dislike your job. Questions about that will come later. Instead, try to make your descriptions as accurate and as objective as you possibly can.

A sample question is given below.

A. To what extent does your job require you to work with mechanical equipment?

1----------2----------3----------4----------5----------6----------7

1	4	7
Very little; the job requires almost no contact with mechanical equipment of any kind.	Moderately	Very much; the job requires almost constant work with mechanical equipment

You are to circle the number which is the most accurate description of your job.

If, for example, your job requires you to work with mechanical equipment a good deal of the time--but also requires some paperwork--you might circle the number six, as was done in the example above.

Turn the page and begin.

1. To what extent does your job require you to work closely with other people (either "clients" or people in related jobs in your own organization)?

1----------2----------3----------4----------5----------6----------7

Very little; dealing with other people is not at all necessary in doing the job.	Moderately; some dealing with others is necessary.	Very much; dealing with other people is an absolutely essential and crucial part of doing the job.

2. How much autonomy is there in your job? That is, to what extent does your job permit you to decide on your own how to go about doing the work?

1----------2----------3----------4----------5----------6----------7

Very little; the job gives me almost no personal "say" about how and when the work is done.	Moderate autonomy; many things are standardized and not under my control, but I can make some decisions about the work.	Very much; the job gives me almost complete responsibility for deciding how and when the work is done.

3. To what extent does your job involve doing a "whole" and identifiable piece of work? That is, is the job a complete piece of work that has an obvious beginning and end? Or is it only a small part of the overall piece of work, which is finished by other people or by automatic machines?

1----------2----------3----------4----------5----------6----------7

My job is only a tiny part of the overall piece of work; the results of my activities cannot be seen in the final product or service.	My job is a moderate-sized "chunk" of the overall piece of work; my own contribution can be seen in the final outcome.	My job involves doing the whole piece of work, from start to finish; the results of my activities are easily seen in the final product or service.

4. How much variety is there in your job? That is, to what extent does the job require you to do many different things at work, using a variety of your skills and talents?

1----------2----------3----------4----------5----------6----------7

Very little; the job requires me to do the same routine things over and over again.	Moderate variety	Very much; the job requires me to do many different things, using a number of different skills and talents.

5. In general, how significant or important is your job? That is, are the results of your work likely to significantly affect the lives or well-being of other people?

1----------2----------3----------4----------5----------6----------7

Not very significant; the outcomes of my work are not likely to have important effects on other people.	Moderately significant	Highly significant; the outcomes of my work can affect other people in very important ways.

6. To what extent do managers or co-workers let you know how well you are doing on your job?

1----------2----------3----------4----------5----------6----------7

Very little; people almost never let me know how well I am doing.	Moderately; sometimes people may give me "feedback;" other times they may not	Very much; managers or co-workers provide me with almost constant "feedback" about how well I am doing.

7. To what extent does doing the job itself provide you with information about your work performance? That is, does the actual work itself provide clues about how well you are doing--aside from any "feedback" co-workers or supervisors may provide?

1----------2----------3----------4----------5----------6----------7

Very little; the job itself is set up so I could work forever without finding out how well I am doing.	Moderately; sometimes doing the job provides "feedback" to me; sometimes it does not.	Very much; the job is set up so that I get almost constant "feedback" as I work about how well I am doing.

SECTION TWO

Listed below are a number of statements which could be used to describe a job.

You are to indicate whether each statement is an accurate or an inaccurate description of your job.

Once again, please try to be as objective as you can in deciding how accurately each statement describes your job--regardless of whether you like or dislike your job.

Write a number in the blank beside each statement, based on the following scale:

How accurate is the statement in describing your job?

1	2	3	4	5	6	7
Very Inaccurate	Mostly Inaccurate	Slightly Inaccurate	Uncertain	Slightly Accurate	Mostly Accurate	Very Accurate

____1. The job requires me to use a number of complex or high level skills.

____2. The job requires a lot of cooperative work with other people.

____3. The job is arranged so that I do not have the chance to do an entire piece of work from beginning to end.

____4. Just doing the work required by the job provides many chances for me to figure out how well I am doing.

____5. The job is quite simple and repetitive.

____6. The job can be done adequately by a person working alone--without talking or checking with other people.

____7. The supervisor and co-workers on this job almost never give me any "feedback" about how well I am doing in my work.

____8. This job is one where a lot of people can be affected by how well the work gets done.

____9. The job denies me any chance to use my personal initiative or judgment in carrying out the work.

____10. Supervisors often let me know how well they think I am performing on the job.

____11. The job provides me the chance to completely finish the pieces of work I begin.

____12. The job itself provides very few clues about whether or not I am performing well.

____13. The job gives me considerable opportunity for independence and freedom in how I do the work.

____14. The job itself is not very significant or important in the broader scheme of things.

SECTION THREE

Now please indicate how you personally feel about your job.

Each of the statements below is something that a person might say about his or her job. You are to indicate your own, personal feelings about your job by marking how much you agree with each of the statements.

Write a number in the blank for each statement, based on this scale:
How much do you agree with the statement?

1	2	3	4	5	6	7
Disagree Strongly	Disagree	Disagree Slightly	Neutral	Agree Slightly	Agree	Agree Strongly

____1. My opinion of myself goes up when I do this job well.

____2. Generally speaking, I am very satisfied with this job.

____3. I feel a great sense of personal satisfaction when I do this job well.

____4. I frequently think of quitting this job.

____5. I feel bad and unhappy when I discover that I have performed poorly on this job.

____6. I am generally satisfied with the kind of work I do in this job.

____7. My own feelings generally are not affected much one way or the other by how well I do on this job.

SECTION FOUR

Now please indicate how satisfied you are with each aspect of your job listed below. Once again, write the appropriate number in the blank beside each statement.

How satisfied are you with this aspect of your job?

1	2	3	4	5	6	7
Extremely Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neutral	Slightly Satisfied	Satisfied	Extremely Satisfied

____1. The amount of job security I have.

____2. The amount of pay and fringe benefits I receive.

____3. The amount of personal growth and development I get in doing my job.

____4. The people I talk to and work with on my job.

____5. The degree of respect and fair treatment I receive from my boss.

____6. The feeling of worthwhile accomplishment I get from doing my job.

____7. The chance to get to know other people while on the job.

____8. The amount of support and guidance I receive from my supervisor.

____9. The degree to which I am fairly paid for what I contribute to this organization.

___10. The amount of independent thought and action I can exercise in my job.

___11. How secure things look for me in the future in this organization.

___12. The chance to help other people while at work.

___13. The amount of challenge in my job.

___14. The overall quality of the supervision I receive in my work.

SECTION FIVE

Listed below are a number of characteristics which could be present on any job. People differ about how much they would like to have each one present in their own jobs. We are interested in learning how much you personally would like to have each one present in your job.

Using the scale below, please indicate the degree to which you would like to have each characteristic present in your job.

NOTE: The numbers on this scale are different from those used in previous scales.

4	5	6	7	8	9	10
Would like having this only a moderate amount (or less)			Would like having this very much			Would like having this extremely much

_____1. High respect and fair treatment from my supervisor.

_____2. Stimulating and challenging work.

_____3. Chances to exercise independent thought and action in my job.

_____4. Great job security.

_____5. Very friendly co-workers.

_____6. Opportunities to learn new things from my work.

_____7. High salary and good fringe benefits.

_____8. Opportunities to be creative and imaginative in my work.

_____9. Quick promotions.

_____10. Opportunities for personal growth and development in my job.

_____11. A sense of worthwhile accomplishment in my work.

APPENDIX C

LETTERS TO NATIONAL LABOR UNIONS

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

Mr. Kenneth T. Blaylock
President, American Federation of
Government Employees
1325 Massachusetts Avenue, N.W.
Washington, D.C. 20005

Dear Mr. Blaylock

As part of the studies in the Air Force Institute of Technology's Graduate Engineering Management Program, the students are required to write a thesis on a suitable topic. 1st Lt Charles P. Smiley is a student in this program and plans to conduct research on recruitment of civilian engineers within the Air Force Base Civil Engineering function.

To accomplish his research, Lt Smiley intends to query a sample of this population by way of a survey package, consisting of a personal questionnaire and the Job Diagnostic Survey. A copy of this package will be mailed to each of the 75 base civil engineers in the squadron. These potential respondents, kept anonymous, will be asked to complete this survey package and mail their replies back to Lt Smiley at Wright-Patterson AFB, OH. Lt Smiley will then evaluate this generated data and apply his findings to his thesis research.

The first section of the package, a personal questionnaire, includes questions concerning the individual and his job (see attachment 2). The responses to these questions will be used to determine which factors are relevant toward civilian engineer retention.

The second section of the package is the Job Diagnostic Survey, created by Hackman and Oldham of Yale University and the University of Illinois, respectively. This survey measures the respondent's attitudes and perceptions toward his/her job and job environment.

The authority for this survey instrument is displayed on page 1 of the package. Participation by potential respondents is entirely voluntary. The Privacy Act of 1974 will be adhered to in every respect, including survey distribution and data evaluation and disposition. Information provided by the data will be used in Lt Smiley's Master's thesis, which will be releasable to the public with unlimited distribution.

This letter is provided for your information. If you have any further questions concerning the research topic or the survey package, please contact me at 513-255-5023.

Sincerely

DAVID R. LEE, Lt Col, USAF
Associate Professor of Engineering
Management
School of Systems and Logistics

2 Atch
1. Questionnaire
2. Job Diagnostic Survey

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

Mr. Kenneth T. Lyons
President, National Association of
Government Employees
2139 Wisconsin Avenue, N.W.
Washington DC 20007

Dear Mr. Lyons

As part of the studies in the Air Force Institute of Technology's Graduate Engineering Management Program, the students are required to write a thesis on a suitable topic. 1st Lt Charles P. Smiley is a student in this program and plans to conduct research on recruitment of civilian engineers within the Air Force Base Civil Engineering function.

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DAVID R. LEE, Lt Col, USAF
Associate Professor of Engineering
Management
School of Systems and Logistics

2 Atch
1. Questionnaire
2. Job Diagnostic Survey

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

Mr. James Pierce, Jr.
President, National Federation of
Federal Employees
1016 16th Street, N.W.
Washington, D.C. 20036

Dear Mr. Pierce

As part of the studies in the Air Force Institute of Technology's Graduate Engineering Management Program, the students are required to write a thesis on a suitable topic. 1st Lt Charles P. Smiley is a student in this program and plans to conduct research on recruitment of civilian engineers within the Air Force Base Civil Engineering function.

To accomplish his research, Lt Smiley intends to query a sample of this population by way of a survey package, consisting of a personal questionnaire and the Job Diagnostic Survey. A copy of this package will be mailed to each of the base civil engineers in the squadron. These potential respondents, kept anonymous, will be asked to complete this survey package and mail their replies back to Lt Smiley at Wright-Patterson AFB, OH. Lt Smiley will then evaluate this generated data and apply his findings to his thesis research.

The first section of the package, a personal questionnaire, includes questions concerning the individual and his job (see attachment 2). The responses to these questions will be used to determine which factors are relevant toward civilian engineer retention.

The second section of the package is the Job Diagnotic Survey, created by Hackman and Oldham of Yale University and the University of Illinois, respectively. This survey measures the respondent's attitudes and perceptions toward his/her job and job environment.

The authority for this survey instrument is displayed on page 1 of the package. Participation by potential respondents is entirely voluntary. The Privacy Act of 1974 will be adhered to in every respect, including survey distribution and data evaluation and disposition. Information provided by the data will be used in Lt Smiley's Master's thesis, which will be releasable to the public with unlimited distribution.

This letter is provided for your information. If you have any further questions concerning the research topic or the survey package, please contact me at 513-255-5023.

Sincerely

DAVID R. LEE, Lt Col, USAF
Associate Professor of Engineering
Management
School of Systems and Logistics

2 Atch
1. Questionnaire
2. Job Diagnostic Survey

APPENDIX D

SCORING KEY FOR THE JOB DIAGNOSTIC SURVEY
SHORT FORM

The Short Form of the Job Diagnostic Survey (JDS) measures several characteristics of jobs, the reactions of the respondents to their jobs, and the growth need strength of the respondents. Some of the scales tapped by the JDS are not included in the Short Form; others are measured with fewer items. The scales measuring the objective job dimensions are, however, identical with those in the JDS.

The variables evaluated by this research are listed below, along with (1) a one or two sentence description of the variable, and (2) a list of the questionnaire items which are averaged to yield a summary score for the variable. The computer format which calculates the value of each variable is also presented in this appendix.

I. JOB DIMENSIONS: Objective characteristics of the job itself.

A. Skill Variety: The degree to which a job requires a variety of different activites in carrying out the work, which involve the use of a number of different skills and talents of the employee.

Average the following items:

Section One #4
Section Two #1
#5 (reversed scoring--i.e., subtract the number entered by the respondent from 8)

B. <u>Task Identity</u>: The degree to which the job requires the completion of a "whole" and identifiable piece of work--i.e., doing a job from beginning to end with a visible outcome.

Average the following items:

Section One	#3	
Section Two	#11	
	#3 (reversed scoring)	

C. <u>Task Significance</u>: The degree to which the job has a substantial impact on the lives or work of other people--whether in the immediate organization or in the external environment.

Average the following items:

Section One	#5	
Section Two	#8	
	#14 (reversed scoring)	

D. <u>Autonomy</u>: The degree to which the job provides substantial freedom, independence, and discretion to the employee in scheduling his work and in determining the procedures to be used in carrying it out.

Average the following items:

Section One	#2	
Section Two	#13	
	#9 (reversed scoring)	

E. <u>Job Feedback</u>: The degree to which carrying out the work activities required by the job results in the employee obtaining information about the effectiveness of his or her performance.

Average the following items:

Section One #7
Section Two #4
#12 (reversed scoring)

II. INDIVIDUAL GROWTH NEED STRENGTH: This scale taps the degree to which an employee has strong versus weak desire to obtain "growth" satisfactions from his or her work.

Average the six items from Section Five listed below. Before averaging, subtract 3 from each item score; this will result in a summary scale ranging from one to seven. The items are: #2, #3, #6, #8, #10, #11

III. MOTIVATING POTENTIAL SCORE: A score reflecting the potential of a job for eliciting positive internal work motivation on the part of employees (especially those with high desire for growth need satisfaction) is given below.

$$\text{Motivation Potential Score (MPS)} = \frac{\text{Skill Variety} + \text{Task Identity} + \text{Task Significance}}{3}$$

$$\text{X Autonomy X Job Feedback} \quad (11:72\text{-}73)$$

Each scored item on the JDS was identified by an alphanumeric code of the form "V_ _ _." The first blank space indicated the Section of the JDS from which the item came. The last two blank spaces indicated the specific entry from the section. For example, "V101" identified the first question in Section 1.

Each of the seven measured variables were also identified by an alphanumeric code of the form "V7 _ _." The five

core job dimensions were coded as:

V701 = Skill Variety
V702 = Task Identity
V703 = Task Significance
V704 = Autonomy
V705 = Job Feedback

The Growth Need Strength moderator was coded as V715 and the Motivating Potential Score was identified by V716.

The values of each measured variable were calculated using a series of "COMPUTE" statements in the computer program. These caluclations were dictated by the JDS Scoring Key. These "COMPUTE" statements took the following format:

```
COMPUTE     V701 = (V104 + V201 + (8 - V205)) / 3
COMPUTE     V702 = (V103 + V211 + (8 - V203)) / 3
COMPUTE     V703 = (V105 + V208 + (8 - V214)) / 3
COMPUTE     V704 = (V102 + V213 + (8 - V209)) / 3
COMPUTE     V705 = (V107 + V204 * (8 - V212)) / 3
COMPUTE     V715 = (V502 + V503 + V506 + V508
                   + V510 + V511 - 18) / 3
COMPUTE     V716 = ((V701 + V702 + V703) / 3) * V704
                                             * V705
```

It should be noted that MPS may be calculated in two different manners. The first method, which was <u>not</u> employed in this research, uses the "V701 through V705" group mean scores to calculate an MPS for the group. By contrast, the second method uses each individual "V701 through V705" measurement to compute a group MPS value. The difference is worth noting the multiplicative effect of the second method tends to inflate the MPS values. However, according to Professor Oldham (one of the co-authors of the Job Characteristics Model), the second method provides more revealing results than does the first method (30).

APPENDIX E

KOLMOGOROV-SMIRNOV GOODNESS-OF-FIT TEST RESULTS

The Kolmogorov-Smirnov (K-S) Goodness-of-Fit test was used to evaluate the observations' probability distributions. Seven dependent variables--the five Job Characteristics Model core job dimensions, Growth Needs Strength, and Motivating Potential Score--were tested to determine if their probability distributions were approximately normal.

All tests were evaluated in the following manner:

H_o: The probability distribution for the variable is approximately normal.

vs. H_a: The probability distribution is not approximately normal.

The variables were evaluated by comparing the computed "Maximum Absolute Difference" value against the tabulated Lilliefors test statistic. If the former value exceeded the latter, the null hypothesis was rejected and the data was not considered to be normal.

The output for the first variable evaluated--Skill Variety--looked like this:

```
----- KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST -----

      V701      SKILL VARIETY

  TEST DIST. - NORMAL (MEAN =     5.7616 STD. DEV. =     1.0003)

      CASES     MAX(ABS DIFF)     MAX(+ DIFF)     MAX(- DIFF)
        358        0.1549           0.1079         -0.1549

      K-S Z        2-TAILED P
      2.931          0.000
```

The tabulated Lilliefors statistic, W_α, was computed as $(0.805)/\sqrt{n}$ for this and the next six variables evaluated. With 358 observations, $W_\alpha = 0.0425$. Therefore, if the computed Maximum Absolute Difference (MAD) was greater than 0.0425, the null hypothesis was rejected.

For Skill Variety, the MAD was computed to be 0.1549. This number is greater than W_α. Therefore, the null hypothesis was rejected, implying that Skill Variety's probability distribution was not normal.

These are the data for Task Identity, the second variable evaluated.

```
- - - - - KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST - - - - -

     V702      TASK IDENTITY

TEST DIST. - NORMAL (MEAN =     5.0307 STD. DEV. =     1.4056)

     CASES      MAX(ABS DIFF)      MAX(+ DIFF)      MAX(- DIFF)
      358          0.1402            0.0806           -0.1402

     K-S Z          2-TAILED P
     2.654            0.000
```

The MAD for the Task Identity variable was computed as 0.1402. The MAD, therefore, exceeded the Lilliefors statistic of 0.0425. Because of this, the null hypothesis was rejected. The probability distribution of this variable could not be considered normal.

The computer output for the third variable examined, Task Significance, took the following form:

----- KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST -----

V703 TASK SIGNIFICANCE

TEST DIST. - NORMAL (MEAN = 5.8026 STD. DEV. = 1.0354)

CASES	MAX(ABS DIFF)	MAX(+ DIFF)	MAX(- DIFF)
358	0.1426	0.1237	-0.1426

K-S Z	2-TAILED P
1.699	0.000

The MAD for this variable was 0.1426, again exceeding the W_α of 0.0425. As with the first two variables, the null hypothesis of approximate normality was rejected.

The fourth of the five JCM core job dimensions, Autonomy, produced this output:

----- KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST -----

V704 AUTONOMY

TEST DIST. - NORMAL (MEAN = 5.3557 STD. DEV. = 1.1874)

CASES	MAX(ABS DIFF)	MAX(+ DIFF)	MAX(- DIFF)
358	0.1536	0.0831	-0.1536

K-S Z	2-TAILED P
1.906	0.000

The MAD for this test, 0.1536, exceeded the W_α-statistic of 0.0425. The null hypothesis, therefore, was rejected. Approximate normality of the data was not found for Autonomy.

The K-S test revealed the following output for the last core job dimension evaluated, Job Feedback:

```
----- KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST ----

      V705      FEEDBACK FROM THE JOB ITSELF

  TEST DIST. - NORMAL (MEAN =     5.1657 STD. DEV. =     1.1667)

      CASES      MAX(ABS DIFF)      MAX(+ DIFF)      MAX(-DIFF)
       358          0.1314            0.0719          -0.1314

      K-S Z         2-TAILED P
      2.487           0.000
```

Once again, the MAD from this experiment, 0.1314, was greater than the Lilliefors statistic of 0.0425. For this reason, the null hypothesis of approximate data normality was rejected.

None of the five JCM core job dimensions were found to have normal probability distributions. Therefore, the parametric Oneway and Duncan procedures were not appropriate to employ for these variables.

Growth Needs Strength scores were examined in an identical manner as the core job dimensions. The computer output for this variable provided this information:

```
----- KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST -----

      V715      GROWTH NEEDS STRENGTH

  TEST DIST. - NORMAL (MEAN =     5.9898 STD. DEV. =     1.0004)

      CASES      MAX(ABS DIFF)      MAX(+ DIFF)      MAX(- DIFF)
       358          0.1563            0.1563          -0.1196

      K-S Z         2-TAILED P
      2.957           0.000
```

The MAD for the Growth Needs Strength variable was 0.1563, exceeding the W_{α}-value of 0.0425. As before, the null hypothesis was rejected. Therefore, the data for this variable did not approximate a normal probability distribution.

The last variable evaluated, Motivating Potential Score, produced this output:

```
----- KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST -----

      V716     MOTIVATING POTENTIAL SCORE

TEST DIST. - NORMAL (MEAN =    160.4597 STD. DEV. =     70.2723)

      CASES      MAX(ABS DIFF)      MAX(+ DIFF)      MAX(- DIFF)
        358         0.0341            0.0341          -0.0306

      K-S Z        2-TAILED P
      0.644          0.801
```

This test revealed that the MAD of 0.0341 was less than Lilliefor's W_{α}-statistic of 0.0425. The null hypothesis could not be rejected in this case. The MPS values, therefore, exhibited an approximately normal probability distribution.

For these last two tests, then, only MPS values were found to be approximately normal. Parametric testing was not appropriate for the GNS variable, but could be applied to MPS values.

APPENDIX F

COCHRAN'S C-TEST OF VARIANCE HOMOGENEITY RESULTS

Cochran's C-test of Variance Homogeneity was used to evaluate the entire sample's Motivating Potential Score probability distribution. Specifically, Cochran's test checks to determine if the factor's variance of observations approximates that of the entire sample. Only MPS values were evaluated because, of the seven variables measured in this research, only these scores were found to be approximately normally distributed (see Appendix E).

All tests were evaluated in the following manner:

H_o: The variance of the factor's measure is approximately equal to that of the entire sample.

vs. H_a: The variance of the factor's measure differs significantly from that of the entire sample.

The MPS variable was evaluated by comparing the "p-statistic" of the test against the established α-level. In all tests, this α-level was equal to 0.10. If the α-level exceeded the p-statistic, the null hypothesis was rejected and unequal variances were assumed.

The first of the variables evaluated, current position of the respondent, produced the following output:

```
TESTS FOR HOMOGENEITY OF VARIANCES
   COCHRAN'S C = MAX. VARIANCE/SUM (VARIANCES) = 0.1530, P = 0.430
                                                          (APPROX.)
```

The α-level of 0.10 was not greater than the p-statistic value of 0.430. Therefore, the null hypothesis could not be rejected, implying approximately equal variances.

The next evaluated factor, respondent's <u>age</u>, produced this data:

```
TESTS FOR HOMOGENEITY OF VARIANCES
    COCHRAN'S C = MAX. VARIANCE/SUM (VARIANCES) = 0.2533, P = 0.219
                                                          (APPROX.)
```

Again, the α-level of 0.10 was not greater than the p-statistic of 0.219. The rejection region of the null hypothesis was not encountered, implying that the variances from the "age" MPS factor were approximately equal to the entire sample.

The last independent variable evaluated on the basis of MPS values was the respondent's current <u>grade</u>. Cochran's test performed on this variable generated the following output:

```
TESTS FOR HOMOGENEITY OF VARIANCES
    COCHRAN'S C = MAX. VARIANCE/SUM (VARIANCES) = 0.3386, P = 0.019
                                                          (APPROX.)
```

The α-level of 0.10 again exceeded the p-statistic value of 0.019. This indicated that the null hypothesis of approximately equal variances was not supported.

In summary, then, the Kolmogorov-Smirnov Goodness-of-Fit tests performed upon the seven dependent variables (Skill Variety, Task Identity, Task Significance, Autonomy, Job Feedback, GNS, and MPS) indicated that only MPS scores were approximately normally distributed. Cochran's C-test of Variance Homogeneity was then run on the MPS distributions of the three independent variables examined (Position, Age, and Grade). Of these MPS distributions, only two displayed

approximately equal variance with the entire sample: Position and Age. Therefore, only these two independent variables' MPS values may undergo parametric statistical testing (Oneway Analysis of Variance and Duncan's Multiple Range test). The Grade variable may only have nonparametric procedures applied to it (Kruskall-Wallis H-test and Dunn's Multiple Comparisons test).

APPENDIX G

DATA ANALYSIS:
RESEARCH OBJECTIVE FOUR

RESEARCH OBJECTIVE FOUR: *Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in all BCE civilian engineering positions.*

Research Hypothesis Four, formulated to evaluate this research objective, stated: "The MPS/GNS measures of all BCE civilian engineering positions are approximately the same."

MPS by Position

For the first part of the test, dealing with MPS values, parametric statistical tests were found to be appropriate (see Appendices E and F). The Oneway Analysis of Variance was performed to determine if a significant statistical difference existed. Duncan's Multiple Range test was then run to determine where the detected difference laid.

The rejection region for the Oneway procedure was established as:

Reject H_O if $F_{experiment} > F_{\alpha,\ (k-1),\ (n-k)}$

The computer output of the test is shown below:

- - - - - O N E W A Y - - - - -

MOTIVATING POTENTIAL SCORE

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RAT.	F PROB.
BETWEEN GROUPS	8	137297.4180	17162.1773	3.684	0.0004
WITHIN GROUPS	349	1625638.8442	4657.9910		
TOTAL	357	1762936.2622			

The tabulated F-value for this experiment (α=0.10, (k-1)=8, (n-k)=349) was 1.6702. The F-value determined from the experiment (the "F RATIO" of the computer output) was 3.684. Since the experimental F-value exceeded the tabulated value, the null hypothesis was rejected. The MPS values, therefore, were not all approximately equal.

Duncan's Multiple Range test, performed at the α=0.10 level of significance, produced the output shown below:

```
                 - - - - - MULTIPLE RANGE TEST - - - - -

DUNCAN PROCEDURE
RANGES FOR THE 0.100 LEVEL -

SUBSET  1

GROUP    GRP06    GRP08    GRP05    GRP04    GRP09    GRP07    GRP03
MEAN   134.1178 139.1305 140.8743 154.4542 155.9442 158.2929 170.7938
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
SUBSET  2

GROUP    GRP03    GRP01    GRP02
MEAN   170.7938 196.1447 214.2649
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

Two relatively homogenous subsets were formed from the nine BCE civilian engineering positions. Composition of these subsets is described more in Chapter 4.

GNS by Position

Growth Need Strength measures of the nine positions were next analyzed. Parametric testing was found to be inappropriate because the probability distribution of GNS scores was not approximately normal (see Appendix E). Two

nonparametric tests--Kruskall-Wallis H-test and Dunn's Multiple Comparisons test--were performed upon GNS values to determine the existence of significant differences among the nine positions.

The Kruskall-Wallis test is a nonparametric Oneway Analysis of Variance. Computer output of this test is displayed below.

```
            - - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

  V715        GROWTH NEEDS STRENGTH
BY CURPOS

    CURPOS      1      2      3      4      5      6      7      8      9
    NUMBER     50     11     20    146     27     24     22     14     44
MEAN RANKS 211.80 144.95 160.25 176.88 189.20 147.83 162.64 157.18 195.73

                                             CORRECTED FOR TIES
CASES    CHI-SQUARE    SIGNIFICANCE    CHI-SQUARE    SIGNIFICANCE
 358       11.684            .166        11.875            .157
```

The null hypothesis of approximately equal GNS scores between the positions was to be rejected if the H-statistic (specified as "CHI-SQUARE" in the computer output) exceeded a tabulated chi-square statistic. This tabulated value (at α=0.10, d.f.=8) equalled 13.4. The H-statistic of 11.684 did not exceed this tabulated value. Therefore, the null hypothesis could not be rejected. The nine positions' probability distributions were approximately equal.

Dunn's test, which must be performed manually, compares the mathematical difference between two groups' probability distributions against a tabulated critical value. In order for no significant difference to be detected, the

absolute value of the mean rank differences had to be less than the tabulated critical value. A significant difference was shown between two groups if the absolute value of the mean rank differences exceeded the tabulated critical value.

The critical value was calculated in this manner:

$$D = z \quad \frac{(N)(N+1)}{12} \quad \frac{1}{n_1} + \frac{1}{n_2}$$

where D = the critical value
z = standard normal distribution value
N = entire sample size
n_1 = size of the first group
n_2 = size of the second group

For all tests involving the nine BCE civilian engineering positions, the D-values are as shown in Figure G-1 of this appendix. The absolute values of the differences between the groups' mean ranks for Growth Need Strength are shown in Figure G-2 of this appendix.

Comparisons show that none of the absolute values exceeded their respective critical values. This finding agreed with the Kruskall-Wallis results of no significant differences between the positions' GNS probability distributions.

Comparison between	Critical value, D
Groups 1,2	105.46
1,3	83.79
1,4	51.89
1,5	75.63
1,6	78.64
1,7	81.02
1,8	95.75
1,9	65.46
Groups 2,3	118.87
2,4	99.01
2,5	113.27
2,6	115.31
2,7	116.94
2,8	127.59
2,9	106.75
Groups 3,4	75.51
3,5	93.43
3,6	95.88
3,7	97.84
3,8	110.35
3,9	85.40
Groups 4,5	66.34
4,6	69.75
4,7	72.42
4,8	88.60
4,9	54.46
Groups 5,6	88.84
5,7	90.95
5,8	104.30
5,9	77.42
Groups 6,7	93.47
6,8	106.50
6,9	80.36
Groups 7,8	108.27
7,9	82.96
Groups 8,9	97.17

Figure G-1. Critical Values Between Positions

	Group j	1	2	3	4	5	6	7	8	9
Group i	$\bar{R}_i$	$\bar{R}_i$-211.80	$\|\bar{R}_i$-144.95	$\|\bar{R}_i$-160.25	$\|\bar{R}_i$-176.88	$\|\bar{R}_i$-189.20	$\|\bar{R}_i$-147.83	$\|\bar{R}_i$-162-64	$\|\bar{R}_i$-157.18	$\|\bar{R}_i$-195.73
1	211.80	0								
2	144.95	66.85	0							
3	160.25	51.55	15.30	0						
4	176.88	34.92	31.93	16.63	0					
5	189.20	22.60	44.25	28.95	12.32	0				
6	147.83	63.97	2.88	12.42	29.05	41.37	0			
7	162.64	49.16	17.69	2.39	14.24	26.56	14.81	0		
8	157.18	54.62	12.23	3.07	19.70	32.02	9.35	5.46	0	
9	195.73	16.07	50.78	35.48	18.85	6.53	47.90	33.09	38.55	0

LEGEND: Group 1 = Deputy BCEs
Group 2 = Chief Engineers
Group 3 = Design Chiefs
Group 4 = Design Engineers
Group 5 = Programmers
Group 6 = Environmental Engineers
Group 7 = Construction Management Chiefs
Group 8 = QAEs/Contract Inspectors
Group 9 = Environmental Planning Chiefs

*significant difference

Figure G-2. Absolute Values of the Differences Between Mean Ranks for Growth Need Strength

APPENDIX H

DATA ANALYSIS:
RESEARCH OBJECTIVE FIVE

RESEARCH OBJECTIVE FIVE: *Determine if the core job dimension measures are approximately equal for all BCE civilian engineering positions.*

Research Hypothesis Five was formulated to evaluate this objective. This hypothesis stated: "The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineering positions are approximately equal."

Each core job dimension was examined separately. None of these dimensions were found to have an approximately normal probability distribution (see Appendix E). Nonparametric statistical tests were performed upon the data to examine the equality of the nine positions' probability distributions.

Skill Variety

The equality of the Skill Variety probability distributions between BCE civilian engineering positions was tested using the Kruskall-Wallis H-test. Output of this test is shown below:

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V701 SKILL VARIETY
BY CURPOS

CURPOS	1	2	3	4	5	6	7	8	9
NUMBER	50	11	20	146	27	24	22	14	44
MEAN RANKS	251.57	242.36	208.22	164.90	113.11	154.69	181.91	138.50	183.39

(continued following page)

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	47.516	.000	48.254	.000

For the null hypothesis of approximately equal probability distributions to be supported, a tabulated chi-square statistic had to exceed the computed H-statistic. In this experiment, this was not the case. The computed H-value of 47.516 was greater than a tabulated chi-square value (at α=0.10, d.f.=8) of 13.4. The null hypothesis was rejected and Dunn's test was performed to ascertain where the significant differences laid.

As in all tests involving the nine BCE civilian engineering positions, Dunn's critical values are as shown in Figure G-1 of Appendix G. The absolute values of the differences between the groups' mean ranks for Skill Variety are shown in Figure H-1 of this appendix. The comparisons reveal that seven significant differences were detected. Once a significant difference was discovered, the group with the larger mean rank, $\bar{R}_i$, was declared greater than the other group. Based on this, the following significant differences were found:

$\text{Skill Variety}_{\text{(Deputy BCEs)}} > \text{Skill Variety}_{\text{(Design Engineers)}}$

$\text{Skill Variety}_{\text{(Deputy BCEs)}} > \text{Skill Variety}_{\text{(Programmers)}}$

$\text{Skill Variety}_{\text{(Deputy BCEs)}} > \text{Skill Variety}_{\text{(Environmental Engineers)}}$

$\text{Skill Variety}_{\text{(Deputy BCEs)}} > \text{Skill Variety}_{\text{(QAEs/Contract Inspectors)}}$

$\text{Skill Variety}_{\text{(Deputy BCEs)}} > \text{Skill Variety}_{\text{(Environmental Planning Chiefs)}}$

Group i	Group j $\bar{R}_i$	1 $\|\bar{R}_i-251.57\|$	2 $\|\bar{R}_i-242.36\|$	3 $\|\bar{R}_i-208.22\|$	4 $\|\bar{R}_i-164.90\|$	5 $\|\bar{R}_i-113.11\|$	6 $\|\bar{R}_i-154.69\|$	7 $\|\bar{R}_i-181.91\|$	8 $\|\bar{R}_i-138.50\|$	9 $\|\bar{R}_i-183.39\|$
1	251.57	0								
2	242.36	9.21	0							
3	208.22	43.35	34.14	0						
4	164.90	86.67*	77.46	43.32	0					
5	113.11	138.46*	129.15*	95.11*	51.79	0				
6	154.69	96.88*	87.67	53.53	10.21	41.58	0			
7	181.91	69.66	60.45	26.31	17.01	68.80	27.22	0		
8	138.50	113.07*	103.86	69.72	26.40	25.39	16.19	43.41	0	
9	183.39	68.18*	58.97	24.83	18.49	70.28	28.70	1.48	44.89	0

LEGEND: Group 1 = Deputy BCEs
Group 2 = Chief Engineers
Group 3 = Design Chiefs
Group 4 = Design Engineers
Group 5 = Programmers
Group 6 = Environmental Engineers
Group 7 = Construction Management Chiefs
Group 8 = QAEs/Contract Inspectors
Group 9 = Environmental Planning Chiefs

*significant difference

Figure H-1. Absolute Values of the Differences Between Mean Ranks for Skill Variety

Skill $Variety_{(Chief\ Engineers)}$ > Skill $Variety_{(Programmers)}$

Skill $Variety_{(Design\ Chiefs)}$ > Skill $Variety_{(Programmers)}$

Task Identity

Probability distributions of the nine positions' Task Identity measures were next tested using the Kruskall-Wallis test. The generated output of this test is shown below:

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V702 TASK IDENTITY
BY CURPOS

CURPOS	1	2	3	4	5	6	7	8	9
NUMBER	50	11	20	146	27	24	22	14	44
MEAN RANKS	147.29	211.27	171.52	204.49	158.20	172.00	178.43	178.39	146.92

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	20.144	.010	20.292	.009

The same statistical experiment was run as in the "Skill Variety" analysis, using the same tabulated chi-square value of 13.4. The computed H-statistic of 20.144 exceeded the tabulated figure, indicating rejection of the null hypothesis of approximately equal probability distributions. Dunn's test was performed to identify the location of the significant difference. Absolute values of group mean rank differences for the "Task Identity" measure are shown in Figure H-2 of this appendix. Critical values for the "Position" comparisons are listed in Figure G-1 of Appendix G.

	Group j	1	2	3	4	5	6	7	8	9
Group i	$\bar{R}_i$	$\bar{R}_i-147.29$	$\lvert\bar{R}_i-211.27\rvert$	$\lvert\bar{R}_i-171.52\rvert$	$\lvert\bar{R}_i-204.49\rvert$	$\lvert\bar{R}_i-158.20\rvert$	$\lvert\bar{R}_i-172.00\rvert$	$\lvert\bar{R}_i-178.43\rvert$	$\lvert\bar{R}_i-178.39\rvert$	$\lvert\bar{R}_i-146.92$
1	147.29	0								
2	211.27	63.98	0							
3	171.52	24.23	39.75	0						
4	204.49	57.20*	6.78	32.97	0					
5	158.20	10.91	53.07	13.32	46.29	0				
6	172.00	24.71	39.27	0.48	32.49	13.80	0			
7	178.43	31.14	32.84	6.91	26.06	20.23	6.43	0		
8	178.39	31.10	32.88	6.87	26.10	20.19	6.39	0.04	0	
9	146.92	0.37	64.35	24.60	57.57*	11.28	25.08	31.51	31.47	0

LEGEND:
Group 1 = Deputy BCEs
Group 2 = Chief Engineers
Group 3 = Design Chiefs
Group 4 = Design Engineers
Group 5 = Programmers
Group 6 = Environmental Engineers
Group 7 = Construction Management Chiefs
Group 8 = QAEs/Contract Inspectors
Group 9 = Environmental Planning Chiefs

*significant difference

Figure H-2. Absolute Values of the Differences Between Mean Ranks for Task Identity

These comparisons show that only one significant difference existed:

Task Identity$_{\text{(Design Engineers)}}$ > Task Identity$_{\text{(Deputy BCEs)}}$

Task Significance

The K-W test also tested for significant differences between the "Task Significance" probability distributions of the nine positions. This test produced the following output:

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V703 TASK SIGNIFICANCE
BY CURPOS

CURPOS	1	2	3	4	5	6	7	8	9
NUMBER	50	11	20	146	27	24	22	14	44
MEAN RANKS	245.02	246.86	216.25	160.18	152.81	134.79	217.61	171.46	159.86

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	43.238	.000	43.885	.000

As with the two prior tests, the computed H-statistic was compared to a tabulated chi-square value for such an experiment. As before, the computed value (43.268) exceeded the tabulated value (13.4). This indicated that rejection of the null hypothesis (predicting approximately equal probability distributions) was appropriate. Dunn's test revealed that four significant differences existed between group probability distributions. This finding was determined by contrasting the critical comparison values (see Figure G-1 of Appendix G) with the absolute values of group mean rank

differences (see Figure H-3 of this appendix). These comparisons identified the following significant differences:

Task Significance$_{\text{(Deputy BCEs)}}$ > Task Significance$_{\text{(Design Engineers)}}$

Task Significance$_{\text{(Deputy BCEs)}}$ > Task Significance$_{\text{(Programmers)}}$

Task Significance$_{\text{(Deputy BCEs)}}$ > Task Significance$_{\text{(Environmental Engineers)}}$

Task Significance$_{\text{(Deputy BCEs)}}$ > Task Significance$_{\text{(Environmental Planning Chiefs)}}$

Autonomy

The "Autonomy" probability distribution was the next dependent variable analyzed by the nine BCE civilian engineering positions. This experiment yielded these results.

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V704 AUTONOMY
BY CURPOS

CURPOS	1	2	3	4	5	6	7	8	9
NUMBER	50	11	20	146	27	24	22	14	44
MEAN RANKS	235.98	244.27	177.52	167.67	159.98	165.58	171.45	136.14	176.65

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	25.133	.001	25.402	.001

Comparing the tabulated chi-square value for an experiment of this type (13.4) against the calculated H-statistic (25.133) revealed a significant difference between at least two probability distributions. Dunn's test was again used to identify the significant differences. The critical values for the comparisons are given in Figure G-1 of Appendix G. The absolute values of group mean rank

Group i	Group j $\bar{R}_i$	1 $\|\bar{R}_i-245.02\|$	2 $\|\bar{R}_i-246.86\|$	3 $\|\bar{R}_i-216.25\|$	4 $\|\bar{R}_i-160.18\|$	5 $\|\bar{R}_i-152.81\|$	6 $\|\bar{R}_i-134.79\|$	7 $\|\bar{R}_i-217.61\|$	8 $\|\bar{R}_i-171.46\|$	9 $\|\bar{R}_i-159.86\|$
1	245.02	0								
2	246.86	1.84	0							
3	216.25	28.77	30.61	0						
4	160.18	84.84*	86.68	56.07	0					
5	152.81	92.21*	94.05	63.44	7.37	0				
6	134.79	110.23*	112.07	81.46	25.39	18.02	0			
7	217.61	27.41	29.25	1.36	57.43	64.80	82.82	0		
8	171.46	73.56	75.40	44.79	11.28	18.65	36.67	46.15	0	
9	159.86	85.16*	87.00	56.39	0.32	7.05	25.07	57.75	11.60	0

LEGEND: Group 1 = Deputy BCEs
Group 2 = Chief Engineers
Group 3 = Design Chiefs
Group 4 = Design Engineers
Group 5 = Programmers
Group 6 = Environmental Engineers
Group 7 = Construction Management Chiefs
Group 8 = QAEs/Contract Inspectors
Group 9 = Environmental Planning Chiefs

*significant difference

Figure H-3. Absolute Values of the Differences Between Mean Ranks for Task Significance

differences for the "Autonomy" measure are shown in Figure H-4 of this appendix. Comparing these values identified that the following probability distributions significantly differ from each other:

$$\text{Autonomy}_{(\text{Deputy BCEs})} > \text{Autonomy}_{(\text{Design Engineers})}$$

$$\text{Autonomy}_{(\text{Deputy BCEs})} > \text{Autonomy}_{(\text{QAEs/Contract Inspectors})}$$

Job Feedback

The fifth and final core job dimension's probability distribution to be analyzed, "Job Feedback," was also performed using the K-W test. Computer output for this test was in this form:

```
                - - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

   V705        FEEDBACK FROM THE JOB ITSELF
BY CURPOS

    CURPOS       1       2       3       4       5       6       7       8       9
    NUMBER      50      11      20     146      27      24      22      14      44
MEAN RANKS  213.67  224.32  190.55  172.23  171.24  137.17  175.95  169.29  181.76

                                            CORRECTED FOR TIES
CASES    CHI-SQUARE    SIGNIFICANCE     CHI-SQUARE    SIGNIFICANCE
  358        12.834            .118         12.992            .112
```

As can be seen from the computer printout, the H-statistic of 12.834 exceeded the tabulated chi-square value of 13.4. The H-statistic did not violate the null hypothesis' rejection region, therefore this hypothesis could not be rejected. All nine positions' probability distributions did not statistically differ. Dunn's Multiple Comparisons test

Group i	Group j $\bar{R}_i$	1 $\bar{R}_i-235.98$	2 $\bar{R}_i-244.27$	3 $\bar{R}_i-177.52$	4 $\bar{R}_i-167.67$	5 $\bar{R}_i-159.98$	6 $\bar{R}_i-165.58$	7 $\bar{R}_i-171.45$	8 $\bar{R}_i-136.14$	9 $\bar{R}_i-176.65$
1	235.98	0								
2	244.27	8.29	0							
3	177.52	58.46	66.75	0						
4	167.67	68.31*	76.60	9.85	0					
5	159.98	76.00*	84.29	17.54	7.69	0				
6	165.58	70.40	78.69	11.94	2.09	5.60	0			
7	171.45	64.53	72.82	6.07	3.78	11.47	5.87	0		
8	136.14	99.84*	108.13	41.38	31.53	23.84	29.44	35.31	0	
9	176.65	59.33	67.62	0.87	8.98	16.67	11.07	5.20	40.51	0

LEGEND: Group 1 = Deputy BCEs
Group 2 = Chief Engineers
Group 3 = Design Chiefs
Group 4 = Design Engineers
Group 5 = Programmers
Group 6 = Environmental Engineers
Group 7 = Construction Management Chiefs
Group 8 = QAEs/Contract Inspectors
Group 9 = Environmental Planning Chiefs

*significant difference

Figure H-4. Absolute Values of the Differences Between Mean Ranks for Autonomy

AD-A124 009 JOB ENRICHMENT APPLICATION TO CIVILIAN ENGINEERS IN BASE CIVIL ENGINEERIN..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYST.. C P SMILEY 3/3

UNCLASSIFIED SEP 82 AFIT-LSSR-71-82 F/G 5/9 NL

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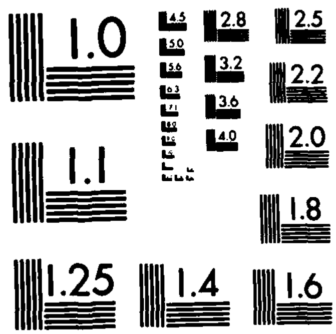

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

upheld this finding. By contrasting the test's critical values (see Figure G-1 in Appendix G) against the absolute values of group mean rank differences for this measure, no significant statistical differences were noted.

	Group j	1	2	3	4	5	6	7	8	9
Group i	$\bar{R}_i$	$\bar{R}_i$-213.67	$\bar{R}_i$-224.32	$\bar{R}_i$-190.55	$\bar{R}_i$-172.23	$\bar{R}_i$-171.24	$\bar{R}_i$-137.17	$\bar{R}_i$-175.95	$\bar{R}_i$-169.29	$\bar{R}_i$-181.76
1	213.67	0								
2	224.32	20.65	0							
3	190.55	23.12	33.77	0						
4	172.23	41.44	52.09	18.32	0					
5	171.24	42.43	53.08	19.31	0.99	0				
6	137.17	76.50	87.15	53.38	35.06	34.07	0			
7	175.95	37.72	48.37	14.60	3.72	4.71	38.78	0		
8	169.29	44.38	55.03	21.26	2.94	1.95	32.12	6.66	0	
9	181.76	31.91	42.56	8.79	9.53	10.52	44.59	5.81	12.47	0

LEGEND: Group 1 = Deputy BCEs
Group 2 = Chief Engineers
Group 3 = Design Chiefs
Group 4 = Design Engineers
Group 5 = Programmers
Group 6 = Environmental Engineers
Group 7 = Construction Management Chiefs
Group 8 = QAEs/Contract Inspectors
Group 9 = Environmental Planning Chiefs

*significant difference

Figure H-5. Absolute Values of the Differences Between Mean Ranks for Job Feedback

APPENDIX I

DATA ANALYSIS: RESEARCH OBJECTIVE SIX

RESEARCH OBJECTIVE SIX: *Determine if the feasibility of, and potential reception to, job enrichment techniques exist equally in both categories (i.e., age and grade) of BCE civilian engineers.*

Research Hypotheses Six and Seven were developed to evaluate this research objective. Each of the two hypotheses examined a single dependent variable separately of the other.

Analysis by Age

Research Hypothesis Six was formulated to evaluate the first part of the sixth research objective. This hypothesis read: "The MPS/GNS measures of all BCE civilian engineers are approximately equal regardless of age."

Motivating Potential Score

The test for MPS equality was first performed. These values, as described in Appendix E, were found to be approximately normal in probability distribution. Appendix F describes that the Age variance was approximately homogenous with that of the entire sample. For these two reasons, parametric testing was deemed appropriate for the "MPS-Age" combination.

To identify the existence of significant statistical differences, the Oneway Analysis of Variance was performed upon the data. Computer output is shown below.

- - - - - O N E W A Y - - - - -

MOTIVATING POTENTIAL SCORE

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	4	96189.9853	24047.4963	5.093	0.0005
WITHIN GROUPS	353	1666746.2768	4721.6608		
TOTAL	357	1762936.2621			

A significant difference could be detected by comparing the computed F-value against a tabulated F-value. If the computed value was found to be greater than the tabulated value, H_o was rejected. This latter value (at α=0.10, (k-1)=4, (n-k)=353) was found to be 1.9449. The computed F-value was 5.093. Since the experimental value exceeded the tabulated value, the null hypothesis of approximate MPS equality was not supported.

Duncan's Multiple Range test was then used to examine the data to determine specific homogenous subgroups of MPS values. Results from this test are shown below.

- - - - - MULTIPLE RANGE TEST - - - - -

DUNCAN PROCEDURE
RANGES FOR THE 0.100 LEVEL

SUBSET 1

GROUP	GRP02	GRP01
MEAN	137.0356	141.7942

SUBSET 2

GROUP	GRP01	GRP03	GRP04
MEAN	141.7942	158.9110	171.5754

SUBSET 3

GROUP	GRP04	GRP05
MEAN	171.5754	183.4144

Three homogenous subsets were identified. Composition of these subsets is described in Chapter 4.

Growth Need Strength

The second dependent variable tested, Growth Need Strength, was accomplished by nonparametric statistical procedures. Parametric testing was found inappropriate upon this variable because its probability function was not normal (see Appendix E). The two nonparametric tests--the Kruskall-Wallis H-test and Dunn's Multiple Comparisons test--were performed to learn of statistically significant differences between the Age treatments.

Computer output of the first nonparametric test is shown below.

```
            - - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

  V715         GROWTH NEEDS STRENGTH
BY AGE         AGE

       AGE          1         2         3         4         5
    NUMBER         12        88       102        96        60
MEAN RANKS     207.21    186.20    173.78    185.21    164.71

                                          CORRECTED  FOR TIES
CASES     CHI-SQUARE    SIGNIFICANCE    CHI-SQUARE    SIGNIFICANCE
  358          3.058            .548         3.109            .540
```

The testing procedure specified that if the computed H-value exceeded the tabulated chi-square statistic, H_o was to be rejected. In this test, the H-statistic was 3.058, less than the tabulated chi-square value (at α=0.10, d.f.=4) of 7.78. No significant differences between the five Age

probability distributions were discovered. Dunn's test, a manual nonparametric test, was then used to verify this result.

Dunn's test uses the group mean ranks from the Kruskall-Wallis test to contrast against a tabulated critical value for that comparison. If the difference between the absolute value of two group's mean ranks exceed this critical value, the two groups statistically differ. This difference, however, is between group <u>probability distributions</u>, not between group <u>means</u>. The critical values for the Age variable are shown in Figure I-1 of this appendix. The absolute values are displayed in Figure I-2 of this appendix.

Comparisons show that all absolute values were less than their corresponding critical differences. This signifies that no significant differences were detected, supporting the Kruskall-Wallis finding.

Analysis by Grade

The second half of the sixth research objective was evaluated by Research Hypothesis Seven: "The MPS/GNS measures of all BCE civilian engineers are approximately equal regardless of General Schedule grade level."

As described in the first section of this appendix, the MPS values were found to be normally distributed. However, results of Cochran's Homogeneity of Variance test

Comparison between	Critical value, D
Groups 1,2	82.03
1,3	81.36
1,4	81.63
1,5	84.30
Groups 2,3	38.79
2,4	39.34
2,5	44.63
Groups 3,4	37.91
3,5	43.37
Groups 4,5	43.87

Figure I-1. Critical Values Between Age Groups

Group i	Group j	1	2	3	4	5
	R_i	R_i-207.21	R_i-186.20	R_i-173.78	R_i-185.21	R_i-164.71
1	207.21	0				
2	186.20	21.01	0			
3	173.78	33.43	12.42	0		
4	185.21	22.00	10.99	11.43	0	
5	164.71	42.50	21.49	9.07	20.50	0

LEGEND: Group 1 = 25 or under *significant difference
Group 2 = 26-35
Group 3 = 36-45
Group 4 = 46-55
Group 5 = 56 or over

Figure I-2. Absolute Values of the Differences Between Mean Ranks for Growth Need Strengths

(shown in Appendix F) found that the Grade variance was equivalent to the overall sample's. Further, the GNS values were not normally distributed. As a result, parametric testing of either the "MPS-Grade" or "GNS-Grade" combination is inappropriate. The nonparametric tests outlined earlier in this appendix were used in both evaluations.

Motivating Potential Score

The MPS probability distributions of the five GS grade levels were first analyzed. Computer output is shown below.

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V716 MOTIVATING POTENTIAL SCORE
BY CURGR CURRENT GRADE

CURGR	1	2	3	4
NUMBER	9	27	297	25
MEAN RANKS	145.56	153.35	179.77	216.72

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	5.928	.115	5.928	.115

Using a tabulated chi-square statistic of 6.25 (α=0.10, d.f.=3) as the basis of comparison, no significant differences were detected. The computed H-statistic of 5.928 was less than the tabulated value, implying that the five groups' values were approximately equally distributed. Dunn's test validated this lack of statistical difference. By comparing the critical values (Figure I-3 of this appendix) against the absolute values (Figure I-4 of this appendix), no

significant variations were detected.

Comparison between	Critical value, D
Groups 1,2	95.36
1,3	83.83
1,4	96.31
Groups 2,3	49.80
2,4	68.76
Groups 3,4	51.59

Figure I-3. Critical Values Between Grade Groups

	Group j	1	2	3	4
Group i	$\bar{R}_i$	$\bar{R}_i$-145.56	$\bar{R}_i$-153.35	$\bar{R}_i$-179.77	$\bar{R}_i$-216.72
1	145.56	0			
2	153.35	7.79	0		
3	179.77	34.21	26.42	0	
4	216.72	71.16	63.37	36.95	0

LEGEND: Group 1 = GS-5 - 7
Group 2 = GS-8 - 10
Group 3 = GS-11 - 13
Group 4 = GS-14 or above

Figure I-4. Absolute Values of the Differences Between Mean Ranks for Motivating Potential Scores

Growth Need Strength

The same results were found for the "GNS-Grade" comparison. The computed H-value of 2.963 was less than the tabulated chi-square statistic of 6.25.

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V715 GROWTH NEEDS STRENGTH
BY CURGR CURRENT GRADE

CURGR	1	2	3	4
NUMBER	9	27	297	25
MEAN RANKS	207.50	199.00	175.27	198.58

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	2.963	.397	3.011	.390

This showed a lack of significant difference between the five grade categories. Dunn's test further supported this finding. Comparing the absolute values in Figure I-5 against the critical values (Figure I-3) showed no statistically significant differences among the treatments.

	Group j	1	2	3	4
Group i	$\bar{R}_i$	$\bar{R}_i$-207.50	$\bar{R}_i$-199.00	$\bar{R}_i$-175.27	$\bar{R}_i$-198.58
1	207.50	0			
2	199.00	8.50	0		
3	175.27	32.23	23.73	0	
4	198.58	8.92	0.42	23.31	0

LEGEND: Group 1 = GS-5 - 7
Group 2 = GS-8 - 10
Group 3 = GS-11 - 13
Group 4 = GS-14 or above

Figure I-5. Absolute Values of the Differences Between Mean Ranks for Growth Need Strength

APPENDIX J

DATA ANALYSIS:
RESEARCH OBJECTIVE SEVEN

RESEARCH OBJECTIVE SEVEN: *Determine if the core job dimension measures are approximately equal for both categories (i.e., age and grade) of BCE civilian engineers.*

Two research hypotheses were formulated to evaluate this research objective. The data analyses of both hypotheses depended solely upon nonparametric statistical procedures. This was forced because of the lack of normality of these five variables (see Appendix E). Each hypothesis was evaluated independently of the other, and is so presented in this appendix.

Analysis by Age

Research Hypothesis Eight was developed to analyze the first half of this research objective. This hypothesis read: "The Skill VAriety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineers are approximately equal regardless of age."

All five core job dimensions were analyzed by Age category using two nonparametric tests: the Kruskall-Wallis H-test and Dunn's Multiple Comparisons test. Each of the dimensions were tested separately.

In the K-W procedure, if the experiment's computed H-statistic exceeded a tabulated chi-square value, the null hypothesis of approximate equality was rejected. If the reverse was true, the null hypothesis could not statistically be rejected and approximate equality was assumed. The Age

category had five treatment groups. At the 90 percent confidence interval, the tabulated chi-square value was 7.78. This was used as the basis of comparison for all five K-W experiments.

Dunn's test used the group mean ranks output of the K-W procedure in its analysis. By comparing the absolute value of the difference between two treatments' mean ranks against a tabulated critical value, significant statistical differences could be isolated. It should be noted that these differences lay between two treatment's probability distributions, not their group means. The critical values used as the basis of comparison can be found in Figure I-4 in Appendix I. The absolute values are listed in figures throughout this appendix.

Skill Variety

The dependent variable Skill Variety was first tested. The nonparametric Kruskall-Wallis procedure run upon this data produced the output shown below:

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V701 SKILL VARIETY
BY AGE AGE

AGE	1	2	3	4	5
NUMBER	12	88	102	96	60
MEAN RANKS	126.38	157.83	184.49	185.57	203.71

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	10.872	.028	11.041	.026

The computed H-statistic in this case was 10.872, exceeding the tabulated chi-square value of 7.78. This indicated rejection of the null hypothesis of approximate equality of the treatment's probability distributions. Dunn's Multiple Comparisons test, a manual procedure, was next used to identify the significant differences.

The absolute values of mean rank differences for the Skill Variety measure are shown in Figure J-1 of this appendix. These values were contrasted against the critical values given in Figure I-1 of Appendix I. Comparison of the values identified only one significant difference between the Age categories. The oldest BCE civilian engineers (age 56 or older) had significantly higher Skill Variety rankings than the second-lowest (26-35 years old) age group.

Task Identity

The second dependent variable, Task Identity, produced the Kruskall-Wallis output shown below:

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V702 TASK IDENTITY
BY AGE AGE

AGE	1	2	3	4	5
NUMBER	12	88	102	96	60
MEAN RANKS	176.71	174.99	176.41	182.30	187.45

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	.692	.952	.697	.952

Group i	Group j	1	2	3	4	5
	$\bar{R}_i$	$\bar{R}_i$-126.38	$\bar{R}_i$-157.83	$\bar{R}_i$-184.49	$\bar{R}_i$-185.57	$\bar{R}_i$-203.71
1	126.38	0				
2	157.83	31.45	0			
3	184.49	58.11	26.66	0		
4	185.57	59.19	27.74	1.08	0	
5	103.71	77.33	45.88*	19.22	18.14	0

LEGEND: Group 1 = 25 or under
Group 2 = 26-35
Group 3 = 36-45
Group 4 = 46-55
Group 5 = 56 or over

*significant difference

Figure J-1. Absolute Values of the Differences Between Mean Ranks for Skill Variety

The computed H-value of 0.692 was less than the tabulated chi-square statistic of 7.78. This indicated that the null hypothesis could not be rejected at a 90 percent confidence interval. All five Age treatments, therefore, had approximately equal probability distributions.

Dunn's test further supported this finding. Comparisons between the absolute values (Figure J-2 of this appendix) and the critical values (Figure I-1 of Appendix I) revealed no statistical differences between the five Age groups.

Group j		1	2	3	4	5
Group i	$\bar{R}_i$	$\bar{R}_i$-176.71	$\bar{R}_i$-174.99	$\bar{R}_i$-176.41	$\bar{R}_i$-182.30	$\bar{R}_i$-187.45
1	176.71	0				
2	174.99	1.72	0			
3	176.41	0.30	1.42	0		
4	182.30	5.59	7.31	5.89	0	
5	187.45	10.74	12.46	11.04	5.15	0

LEGEND: Group 1 = 25 or under *significant difference
Group 2 = 26-35
Group 3 = 36-45
Group 4 = 46-55
Group 5 = 56 or over

Figure J-2. Absolute Values of the Differences Between Mean Ranks for Task Identity

Task Significance

Listed below is the computer output of the K-W test performed upon the Task Significance variable.

```
- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

  V703          TASK SIGNIFICANCE
BY AGE          AGE

        AGE          1          2          3          4          5
     NUMBER         12         88        102         96         60
MEAN RANKS      135.46     149.20     185.93     196.03     195.38

                                           CORRECTED FOR TIES
CASES    CHI-SQUARE    SIGNIFICANCE    CHI-SQUARE    SIGNIFICANCE
  358        13.972            .007        14.181            .007
```

In this case, the experiment's H-statistic (13.972) was greater than the tabulated value (7.78). The null hypothesis of approximately equal probability distributions was therefore not supported. Dunn's test isolated two statistically significant differences between the five Age groupings. Both of the two eldest treatments (46-55, and 56 or over) had mean rankings significantly higher than the 26-35 category. Figure J-3 of this appendix shows the absolute values for this test.

	Group j	1	2	3	4	5
Group i	$\bar{R}_i$	$\bar{R}_i$-135.46	$\bar{R}_i$-149.20	$\bar{R}_i$-185.93	$\bar{R}_i$-196.03	$\bar{R}_i$-195.38
1	135.46	0				
2	149.20	13.74	0			
3	185.93	50.47	36.73	0		
4	196.03	60.57	46.83*	10.10	0	
5	195.38	59.92	46.18*	9.45	0.65	0

LEGEND: Group 1 = 25 or under
Group 2 = 26-35
Group 3 = 36-45
Group 4 = 46-55
Group 5 = 56 or over

*significant difference

Figure J-3. Absolute Values of the Differences Between Mean Ranks for Task Significance

Autonomy

The K-W output for the next dependent variable tested by Age category, Autonomy, is given below.

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V704	AUTONOMY				
BY AGE	AGE				
AGE	1	2	3	4	5
NUMBER	12	88	102	96	60
MEAN RANKS	165.46	160.30	176.70	188.51	200.82

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	6.597	.159	6.667	.155

The H-value for this experiment, 6.597, was less than the chi-square statistic of 7.78. No significant differences between group probability distributions were detected by this test. Dunn's test supported the Kruskall-Wallis findings. None of the absolute values (Figure J-4 of this appendix) exceeded the tabulated critical values. All five Age categories had approximately equal Autonomy probability distributions.

Job Feedback

The fifth and final Age variable tested, Job Feedback, produced the Kruskall-Wallis output listed below.

	Group j	1	2	3	4	5
Group i	$\bar{R}_i$	$\bar{R}_i$-165.46	$\bar{R}_i$-160.30	$\bar{R}_i$-176-70	$\bar{R}_i$-188.51	$\bar{R}_i$-200.82
1	165.46	0				
2	160.30	5.16	0			
3	176.70	11.24	16.40	0		
4	188.51	23.05	28.21	11.81	0	
5	200.82	35.36	40.52	24.12	12.31	0

LEGEND: Group 1 = 25 or under *significant difference
Group 2 = 26-35
Group 3 = 36-45
Group 4 = 46-55
Group 5 = 56 or over

Figure J-4. Absolute Values of the Differences Between Mean Ranks for Autonomy

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V705 FEEDBACK FROM THE JOB ITSELF
BY AGE AGE

AGE	1	2	3	4	5
NUMBER	12	88	102	96	60
MEAN RANKS	155.21	146.76	178.64	195.10	208.88

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	16.494	.002	16.697	.002

This test's calculated H-statistic exceeded the tabulated chi-square statistic (16.494 versus 7.78, respectively). A statistical difference was indicated between at least two probability distributions. Comparing the manually-derived absolute values of Dunn's test, shown in Figure J-5

of this appendix, against the tabulated critical values showed two statistically significant differences. As with the Task Significance variable, both of the two oldest categories (46-55, and 56 or older) were found to have significantly higher probability distributions than the 26-35 group.

	Group j	1	2	3	4	5
Group i	$\bar{R}_i$	$\bar{R}_i$-155.21	$\bar{R}_i$-145.76	$\bar{R}_i$-178.64	$\bar{R}_i$-195.10	$\bar{R}_i$-208.88
1	155.21	0				
2	145.76	9.45	0			
3	178.64	23.43	32.88	0		
4	195.10	39.89	49.34*	16.46	0	
5	108.88	53.67	63.12*	30.24	13.78	0

LEGEND: Group 1 = 25 or under
Group 2 = 26-35
Group 3 = 36-45
Group 4 = 46-55
Group 5 = 56 or over

*significant difference

Figure J-6. Absolute Values of the Differences Between Mean Ranks for Job Feedback

Analysis by Grade

Research Hypothesis Nine evaluated the second part of the research objective. This hypothesis read: "The Skill Variety (or Task Identity/Task Significance/Autonomy/Job Feedback) measures of all BCE civilian engineers are approximately equal regardless of grade."

The same evaluation techniques as before--the Kurskall-Wallis H-test and Dunn's Multiple Comparisons test--were used to analyze the data. The testing procedures for both tests are the same as with the Age independent variable. The only difference lay in the tabulated chi-square statistic of the K-W test. With only four treatments, this statistic was 6.25.

Skill Variety

Computer output of the Kruskall-Wallis procedure is shown below for this variable:

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V701 SKILL VARIETY
BY CURGR CURRENT GRADE

CURGR	1	2	3	4
NUMBER	9	27	297	25
MEAN RANKS	179.22	134.94	178.30	241.98

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	14.157	.003	14.377	.002

Analysis revealed an H-statistic of 14.157, exceeding the tabulated chi-square statistic of 6.25. Therefore, the null hypothesis of approximate equality was rejected. Dunn's test produced the data given in Figure J-6 of this appendix. Comparison of this information with the critical values displayed in Figure I-3 of Appendix I revealed two significant differences existed. The highest grade category (GS-14 or above) had a Skill Variety probability distribution

statistically greater than both the GS-8 to GS-10 and the GS-11 to GS-13 grade categories.

Group j		1	2	3	4
Group i	$\bar{R}_i$	$\bar{R}_i$-179.22	$\bar{R}_i$-134.94	$\bar{R}_i$-178.30	$\bar{R}_i$-241.98
1	179.22	0			
2	134.94	44.28	0		
3	178.30	0.92	43.36	0	
4	241.98	62.76	107.04*	63.68*	0

LEGEND: Group 1 = GS-5 - 7
Group 2 = GS-8 - 10
Group 3 = GS-11 - 13
Group 4 = GS-14 or above

*significant difference

Figure J-6. Absolute Values of the Differences Between Mean Ranks for Skill Variety

Task Identity

The Kruskall-Wallis test computed an H-value of 2.774 for the Task Identity measure (see computer output below):

```
            - - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

  V702        TASK IDENTITY
BY CURGR      CURRENT GRADE

    CURGR          1          2          3          4
   NUMBER          9         27        297         25
MEAN RANKS    194.28     171.35     182.37     148.84

                                          CORRECTED FOR TIES
CASES    CHI-SQUARE    SIGNIFICANCE    CHI-SQUARE    SIGNIFICANCE
  358        2.774            .428         2.795            .424
```

This was lower than the tabulated chi-square statistic of 6.25, indicating acceptance of the null hypothesis. All four treatments' probability distributions were approximately equal. Dunn's test supported this finding. Comparisons of the data in Figure J-7 of this appendix with the critical values failed to detect any significant differences.

	Group j	1	2	3	4
Group i	$\bar{R}_i$	$\bar{R}_i$-194.28	$\bar{R}_i$-171.35	$\bar{R}_i$-182.37	$\bar{R}_i$-148.84
1	194.28	0			
2	171.35	22.93	0		
3	182.37	11.91	11.02	0	
4	148.84	45.44	22.51	33.53	0

LEGEND: Group 1 = GS-5 - 7 *significant difference
Group 2 = GS-8 - 10
Group 3 = GS-11 - 13
Group 4 = GS-14 or above

Figure J-7. Absolute Values of the Differences Between Mean Ranks for Task Identity

Task Significance

The Task Significance H-statistic of 10.609 (see computer output below) was greater than the tabulated value of 6.25.

- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

V703	TASK SIGNIFICANCE				
BY CURGR	CURRENT GRADE				

CURGR	1	2	3	4
NUMBER	9	27	297	25
MEAN RANKS	199.17	135.83	178.80	227.88

			CORRECTED FOR TIES	
CASES	CHI-SQUARE	SIGNIFICANCE	CHI-SQUARE	SIGNIFICANCE
358	10.609	.014	10.768	.013

This indicated rejection of the null hypothesis. At least two treatments, therefore, were found to differ significantly. Dunn's test revealed that one such difference existed. The senior grade category had a probability distribution statistically greater than the GS-8 to GS-10 category. Test output of absolute values is shown in Figure J-8 of this appendix.

	Group j	1	2	3	4
Group i	$\bar{R}_i$	$\bar{R}_i$-199.17	$\bar{R}_i$-135.83	$\bar{R}_i$-178.80	$\bar{R}_i$-227.88
1	199.17	0			
2	135.83	63.34	0		
3	178.80	20.37	42.97	0	
4	227.88	28.71	92.05*	49.08	0

LEGEND: Group 1 = GS-5 - 7 *significant difference
Group 2 = GS-8 - 10
Group 3 = GS-11 - 13
Group 4 = GS-14 or above

Figure J-8. Absolute Values of the Differences Between Mean Ranks for Task Significance

Autonomy

The fourth dependent variable tested, Autonomy, produced the Kruskall-Wallis output shown below:

```
----- KRUSKAL-WALLIS 1-WAY ANOVA -----

   V704         AUTONOMY
BY CURGR        CURRENT GRADE

     CURGR           1          2          3          4
    NUMBER           9         27        297         25
MEAN RANKS      120.06     147.87     179.24     238.10

                                             CORRECTED FOR TIES
CASES     CHI-SQUARE    SIGNIFICANCE    CHI-SQUARE    SIGNIFICANCE
  358         13.509            .004        13.653            .003
```

This test's computed H-statistic of 13.509 was greater than the tabulated chi-square value of 6.25. The null hypothesis was rejected in favor of unequal probability distributions. Dunn's test found three significant differences. The absolute values, shown in Figure J-9 of this appendix, exceeded the critical values for three comparisons, all of which concerned the highest grade category. This category (GS-14 or above) had significantly greater probability distributions than each of the lowest three grade categories (GS-5 - 7, GS-8 - 10, and GS-11 - 13).

Group j		1	2	3	4
Group i	$\bar{R}_i$	$\bar{R}_i$-120.06	$\bar{R}_i$-147.87	$\bar{R}_i$-179.24	$\bar{R}_i$-238.10
1	120.06	0			
2	147.87	27.81	0		
3	179.24	59.18	31.37	0	
4	238.10	118.04*	90.23*	58.86*	0

LEGEND: Group 1 = GS-5 - 7 *significant differences
Group 2 = GS-8 - 10
Group 3 = GS-11 - 13
Group 4 = GS-14 or above

Figure J-9. Absolute Values of the Differences Between Mean Ranks for Autonomy

Job Feedback

The last variable tested, Job Feedback, indicated no significant differences from the K-W test. Its output is shown below:

```
- - - - - KRUSKAL-WALLIS 1-WAY ANOVA - - - - -

   V705        FEEDBACK FROM THE JOB ITSELF
BY CURGR       CURRENT GRADE


     CURGR          1         2         3         4
    NUMBER          9        27       297        25
MEAN RANKS     143.94    159.74    179.43    214.48

                                           CORRECTED FOR TIES
CASES    CHI-SQUARE    SIGNIFICANCE    CHI-SQUARE    SIGNIFICANCE
  358         4.903            .179         4.963            .175
```

The computed H-statistic of 4.903 was less than the tabulated chi-square statistic of 6.25. Rejection of the null hypothesis was not supported. All of the treatments' probability distributions were approximately equal. The comparisons of Dunn's test verified this finding. None of the absolute values (Figure J-10 of this appendix) exceeded their respective critical values, indicating no significant differences.

Group j		1	2	3	4
Group i	$\bar{R}_i$	$\bar{R}_i$-143.94	$\bar{R}_i$-159.74	$\bar{R}_i$-179.43	$\bar{R}_i$-214.48
1	143.94	0			
2	159.74	15.80	0		
3	179.43	35.49	19.69	0	
4	214.48	70.54	54.74	35.05	0

LEGEND: Group 1 = GS-5 - 7 *significant difference
Group 2 = GS-8 - 10
Group 3 = GS-11 - 13
Group 4 = GS-14 or above

Figure J-10. Absolute Values of the Differences Between Mean Ranks for Job Feedback

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